Chapter 6 Screening of Priority EE&C Measures

In this chapter, EE&C measures to be considered in the Study are initially evaluated for screening priority from viewpoints of impact of the measures and cost/benefit phase. After a screening evaluation, the framework design for each measure is studied in the next chapter.

6.1 Approach to Screening Priority Measures

6.1.1 EE&C Measures to be Evaluated

(1) EE&C Measures to be Evaluated

The EE&C measures to be evaluated are limited to the following five measures which can be numerically estimated for the impact on the measures and cost/benefit phase.

- ✧ Energy Management System
- ✧ Minimum Energy Standards and Labeling System
- ✧ EE&C Building Regulation
- ✧ DSM Tariff System
- ✧ Smart Meter (Automatic Meter Reading and Monitoring System)

(2) Concept of Each EE&C Measure to be Evaluated

The concepts of EE&C measures should be defined for the initial evaluation. In consideration of similar concepts adopted by Japan and a neighboring country (Saudi Arabia), the concepts were defined as described in the following conditions.

(a) Energy Management System

The conditions for the concept of this scheme are defined as follows.

- Targets of the scheme are large energy consuming factories and buildings. As for factories, 70 % of energy consumption in the industrial sector is covered. As for buildings, 30 % of energy consumption in the commercial and government sector is covered.
- Target sites must annually submit a periodical report with an EE&C plan to a regulatory body and assign an energy responsible person (energy manager). The energy manager who is qualified by a national qualification system plays a main role for EE&C activities in the site and aims at an annual 1 % improvement of energy intensity (the improvement rate adopted the same target as the Japanese scheme).
- After the introduction of the scheme, the effect will be realized in all the target sites (100 %) within 1 year and continue afterwards as well.

(b) Minimum Energy Standards and Labeling System

The conditions for the concept of this scheme are defined as follows.

- Target sectors and products are the AC, refrigerator, lamp in the residential sector and lamp in the commercial and government sector.
- With the introduction of the scheme, residential ACs in the Oman market will improve 30 % of the average efficiency, residential refrigerators in the market will reduce 15 % of the average electricity consumption and lamps in the market will improve 10 % of the average efficiency (there the improvement rates adopted half of the values of achievement from 1997 to 2004 in the Japanese scheme).
- After the introduction of the scheme, new equipment satisfying the standards will gradually replace and complete a 100 % replacement within 10 years.

(c) EE&C Building Regulation

The conditions for the concept of this scheme are defined as follows.

- Targets of the scheme are buildings enveloped in the residential, commercial and government sector.
- With the introduction of the scheme, AC's electricity consumption will reduce 28 % in the residential houses and 25 % in the commercial and government buildings respectively (these improvement rates adopted the results of a simulation study in Saudi Arabia which was conducted by the JICA Study Team in another master plan study).
- After the introduction of the scheme, a new envelop satisfying the regulation will gradually replace the timing of the replacement of houses and buildings and complete a 50 % replacement within 20 years.

(d) DSM Tariff System

The conditions for the concept of this scheme are defined as follows.

- To customers in the industrial sector (factory customers) and customers in the commercial and government sector (building customers), TOU (Time of Use) tariff system is provided as an optional tariff system (customers can select the standard tariff or the TOU tariff).
- The TOU tariff expects cost savings in the electricity supply facilities and their O&M costs via the reduction of peak demand (kW). In other words, the total electricity consumption will be equal even after the peak shift because the same amount of the reduced peak demand will be shifted to the off-peak demand time zone.
- It is assumed that the TOU tariff affects the 0.06 % shift in the peak demand of the industrial sector and a 0.04 % shift in the peak demand of the commercial and government sector when 1 % of the total demand in these sectors changes to the TOU tariff. In other words, if 100 % of the total demand changes to the TOU tariff, the peak demand in the industrial sector and the commercial and government sector shift

6 % and 4 % respectively (these values adopted the results of the achievement in early 2000 in Japan).

- After the introduction of the scheme, 60 % of the total demand in the industrial sector and the commercial and government sector selects the TOU tariff within 1 year.

(e) Smart Meter (Automatic Meter Reading and Monitoring System)

The conditions for the concept of this system are defined as follows.

- In the residential sector, all the existing mechanical meters are replaced by digital meters which have multiple functions.
- The multi-functioned digital meter (Smart Meter) has a 2 way communication system to have not only an automatic meter reading function, a detection function to prevent power thefts, etc. but also a visual breakdown function of electricity consumption. With the visual breakdown of electricity consumption, an average 1.8 % of electricity consumption in residential houses, who have installed the system, will reduce by improvement of awareness (the improvement rate adopted the results of a pilot project in Japan).
- After the introduction of the system, 100 % of the residential customers will be replaced within one year, and 68 % of the customers will have a cooperative will to achieve energy saving actions (the value of 68 % adopted the results of a pilot project in Japan). Out of which, only the customers who have an internet system in their houses can utilize the visualization equipment (the internet diffusion rate in Oman was 41.7 % in 2010). As a result, 28 % (=68 % x 41.7 %) of residential houses can reduce their electricity consumption (1.8 %) using smart meters that provide a visual breakdown.

(f) Summary

The above conditions are summarized as follows:

Table 6- 1 Summary of Conditions of Each EE&C Measure to be Evaluated

	Status	Target Sector	Designated Target or Equipment	Expected Effect	Final Diffusion Rate	Time to Finally Diffuse
Energy Management System	Mandatory	Industrial	Factories which cover 70 % of total energy consumption in the industrial sector	Annual 1 % improvement of energy intensity	100 %	1 year
		Commercial and Government	Buildings which cover 30 % of total energy consumption in the commercial and government sector			
Minimum Energy Standards and Labeling System	Mandatory	Residential	AC	30 % efficiency improvement	100 %	10 years
			Refrigerator	15 % reduction of electricity consumption		
			Lamp	10 % efficiency improvement		
		Commercial and Government	Lamp			
EE&C Building Regulation	Mandatory	Residential	Building envelop of houses (Electricity consumption of AC)	28 % reduction of AC electricity consumption	50 %	20 years
		Commercial and Government	Building envelop of buildings (Electricity consumption of AC)	25 % reduction of AC electricity consumption		
DSM Tariff System (TOU Tariff System)	Voluntary	Industrial	Electricity equipment in the industrial sector	6 % peak shift in the peak demand	60 %	1 year
		Commercial and Government	Electricity equipment in the commercial and government sector	4 % peak shift in the peak demand		
Smart Meter (Visualization Function)	Voluntary	Residential	Residential houses which are cooperative for EE&C actions and have internet system.	1.8 % reduction of electricity consumption in the house	28 %	1 year

6.1.2 Evaluation Methods

(1) Evaluation Points of the Effects of the EE&C Measures

The effects of each EE&C measure will take into consideration the following benefits.

Table 6- 2 Evaluation Points for Effects of the EE&C Measures

	Evaluation Points
Energy Management System	• Reduction of energy consumption in primary energy
Minimum Energy Standards and Labeling System	• Reduction of electricity consumption • Reduction of power demand in the peak time
EE&C Building Regulation	• Reduction of electricity consumption • Reduction of power demand in the peak time
DSM Tariff System (TOU Tariff System)	• Reduction of power demand in the peak time (peak shift by price incentive)
Smart Meter (Visualization Function)	• Reduction of electricity consumption

(2) Evaluation Methods for the EE&C Measures

Each EE&C measure's schedule differs in terms of when the effects will be manifested and in their evaluation points. To evaluate these measures under the same conditions, an annual levelized method is adopted (all the accumulated effects during the effective period are levelized in a one year's effect). Besides, in order to compare the effects under the same unit, the annual levelized effects are converted to their monetary value. The methodology is described below.

(a) Annual Levelized Methods

Each measure can be categorized into the following 2 cases in terms of the effect manifestation patterns.

Case 1: From the 1st year of the introduction, the effects gradually increase and are accumulated afterwards. For example, in case an effect increases proportionally from the 1st year to the 10th years, the annual levelized effect is calculated at 5.5 times of the 1st year's effect (= (1+10)/2).

Case 2: Within the 1st year of the introduction, a scheme diffuses at the maximum and continuously realizes the effects during the effective period. For example, in case the effect of the 1st year continues equally during the 10 years, the effect of the 1st year is regarded as the annual levelized effect.

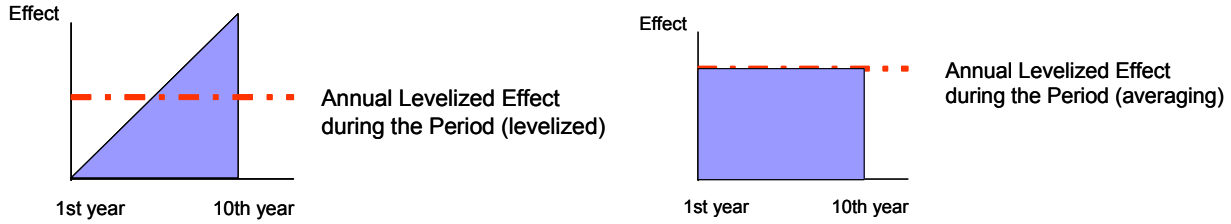


Image of Case 1 Image of Case 2

Figure 6- 1 Image of Annual Levelized Methods

(b) Monetary Value Conversion Methods

For the three evaluation points mentioned above, the following methods are utilized for conversion to monetary value.

Table 6- 3 Conversion Methods to Monetary Value

Evaluation Point	Expected Benefits	Unit Price for Conversion to Monetary Value
Reduction of Energy Consumption in Primary Energy	• All the primary energy used in the industrial, commercial and government sector is regarded as natural gas. • Increase of natural gas exports of by reducing domestic usage is regarded as beneficial.	• Assuming export price of natural gas is 10 US$/MMBtu, 10 US$ per 1 MMBtu is the unit price for conversion.
Reduction of Electricity Consumption	• Natural gas consumption as fuel in power plants can be decreased by reducing electricity consumption in the final stage of energy consumption. • Increase of natural gas exports by reducing domestic usage is regarded as beneficial	• When 1 kWh in final energy consumption is reduced, it leads to a reduction of 1.136 kWh in generation. *1 • 1.136 kWh in generation uses 0.011 MMBtu of natural gas. *1 • Therefore, when 1 kWh in final energy consumption is reduced, natural gas export increases at 0.11 US$ per 1 kWh (when 1 kWh in a sending point of power plant is reduced, natural gas export increases at 0.10 US$ per 1 kWh).
Reduction of Power Demand in the Peak Time	• Construction of a new power plant can be avoided by reducing power demand during peak hours. • Power plants whose originally planned generation amounts have been decreased are assumed to be natural gas power plants. Avoided construction costs and fixed O&M costs in natural gas power plant are regarded as beneficial.	• Assuming construction unit cost of natural gas power plant is 800 US$/kW, 50 US$/kW/year is regarded as benefits under a condition of 16 years project life. • Assuming fixed O&M costs of natural gas power plant is 40 US$/kW/year, 90 US$/kW/year is regarded as total benefits by avoided costs.

*1: The following conditions are used for conversion from electricity consumption in final energy consumer to generation.

- Transmission and distribution loss: 12 %
- Thermal efficiency of natural gas power plant : 34 % (= 10,546 kJ/kWh)
- 1 MMBtu = 1.055 GJ

(c) Baseline Year for Evaluation

As mentioned above, the annual levelized method is used to evaluate the benefits of each EE&C measure. At the time (May 2012) that the JICA Study Team conducted evaluations, 2011 data was not available at all. Therefore, an evaluation is made assuming that the 2010 data is used for the baseline year and the effects of each EE&C measure realized from 2011.

6.2 Estimation of Benefits of Each EE&C Measure

6.2.1 Energy Management System

(1) Assumption for Calculation of Benefits

Assumption for the benefit calculation is described below.

- Factories which cover 70 % of energy consumption in the industrial sector achieved a 1 % reduction of energy consumption in 2011 compared with 2010 (this is equivalent to a 1 % improvement of the energy intensity if the production volume is constant between 2010 and 2011). The annual effect will continuously accumulated until 2020.
- Buildings which cover 30 % of energy consumption in the commercial and government sector achieved a 1 % reduction of energy consumption in 2011 compared to 2010 (this is equivalent to a 1 % improvement of energy intensity if the floor area of the buildings is constant between 2010 and 2011). The annual effect is continuously accumulated until 2020.
- According to the IEA database, the final energy consumption of the industrial sector in 2010 was 3,466 ktoe in fuel and 132 ktoe in electricity. All the fuels used in the industrial sector are assumed to be natural gas.
- According to the AER, the final consumer's electricity consumption in the commercial and government sector in 2011 was 5,755 GWh.

(2) Calculation Results

Based on the above assumption, the annual levelized effect of the scheme is calculated as follows. In the whole industrial, commercial and government sector, 148 ktoe/year (for fuel) and 110 GWh/year (generation) are expected to be reduced during the period. The monetary value converted is estimated at 69 million US$/year on average.

Table 6- 4 Calculation Results

	Industrial Sector (Factories)	Commercial and Government Sector (Buildings)
Energy Consumption in 2010	Fuel 3,466 ktoe + Electricity 132 ktoe (in final energy consumption)	Electricity 5,755 GWh (in final energy consumption)
Conversion	Conversion to Primary Energy Fuel 3,466 ktoe + Electricity 441 ktoe (=132 ktoe / 0.88 / 0.34)	Conversion to Generation Electricity 6,755 GWh (=5,755 GWh / 0.88)
Coverage by the Scheme	2,734 ktoe (=3,907 ktoe x 70 %)	2,026 GWh (=6,755 GWh x 30 %)
Expected EE&C Effect in 2011	27 ktoe (= 2,734 ktoe x 1 %)	20 GWh (=2,026 GWh x 1 %)
Annual Levelized Effect during 10 Years	148 ktoe (= 27 ktoe x 5.5)	110 GWh (= 20 GWh x 5.5)
Monetary Value of Annual Levelized Effect	58 million US$/year	11 milllion US$/year

* 1 toe = 39. 683 MMBtu、10 US$/MMBtu、0.10 US$/kWh

6.2.2 Minimum Energy Standards and Labeling System

(1) Assumption of the Calculation of the Benefits

Assumptions of the calculation of the benefits are described below.

- It is assumed that gradually 100% of the target equipment will be replaced within 10 years (annually 10 % replacement).
- Based on the MIS annual load curve in 2010 obtained from OETC, a sector-wise power demand breakdown was estimated. Utilizing the estimated power demand breakdown, an electricity reduction effects of each of the target equipment are calculated. The load curve is represented by net production (that is electricity at sending points in a generation side).
- The electricity reduction effects in the whole of Oman is calculated by MIS's effect being multiplied 1.14 times in consideration of the proportion of the electricity sales record of MIS and other areas (MIS:DPC:RAECO = 100:11:3).

(2) Calculation of the EE&C Effect of AC in the Residential Sector

(a) Electricity Reduction Effect

In the following figure (MIS's annual load curve), the gap between summer and winter is assumed to be the AC demand. Out of which, the AC demand in the residential sector (4,420 GWh) can be reduced. As a result, the annual electricity reduction effect during the 10 years is calculated at 638 GWh.

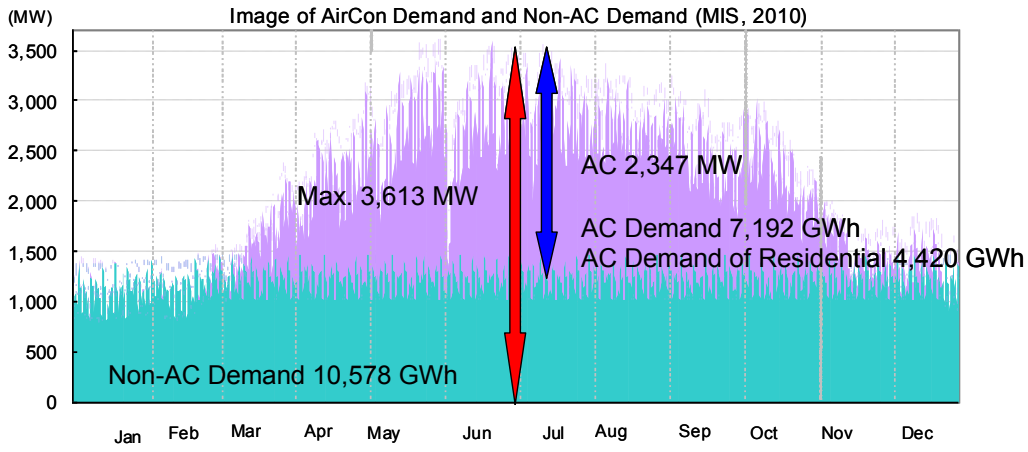


Figure 6- 2 Estimation of Electricity Consumption of AC in the Residential Sector from MIS's Annual Load Curve (Estimated by JICA Study Team)

(Calculation Result)

- AC demand in the residential sector within MIS in 2010: 4,420 GWh
- Electricity reduction effect when 10 % of new ACs, which can achieve a 30 % energy efficiency improvement, are replaced within MIS in 2011: 102 GWh (= (4,420 GWh – (4,420 GWh / 130 %)) x 10 %)
- Electricity reduction effect in the whole of Oman: 116 GWh (=102 GWh x 1.14)

- Annual levelized effect assuming 100 % is replaced within 10 years: 638 GWh (=116 GWh x 5.5)

(b) Reduction Effect of Peak Demand during Peak Hours

From the following figure (typical daily load curve in the summer within MIS), the AC demand in the residential sector in the peak time (15:00) is assumed to be 1,036 MW. As a result of the calculation shown below, the annual peak demand reduction effect over the 10 years is calculated at 148 MW.

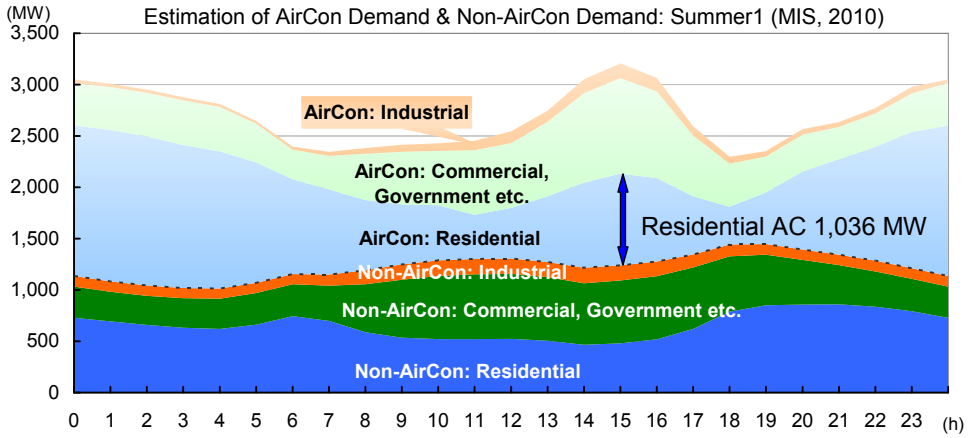


Figure 6.3 Estimation of Peak Demand of AC in the Residential Sector from a Typical Daily Load Curve in the Summer within MIS (Estimated by the JICA Study Team)

(Calculation Result)

- AC demand in the residential sector during peak hours within MIS in 2010: 1,036 MW
- Reduction effect of peak demand when 10 % of new ACs, which can improve 30 % in energy efficiency, are replaced within MIS in 2011: 24 MW (= (1,036 MW – (1,036 MW / 130 %)) x 10 %)
- Reduction effect of peak demand in the whole of Oman: 27 MW (=24 MW x 1.14)
- Annual levelized effect assuming 100 % replacements within 10 years: 148 MW (=27 MW x 5.5)

(3) Calculation of EE&C Effect of Refrigerators in the Residential Sector

(a) Electricity Reduction Effect

From the following figure (MIS's annual load curve), the refrigerator's demand in the residential sector within MIS is assumed to be 1,182 GWh. As a result of the calculation below, the annual electricity reduction effect during the 10 years is calculated at 104 GWh.

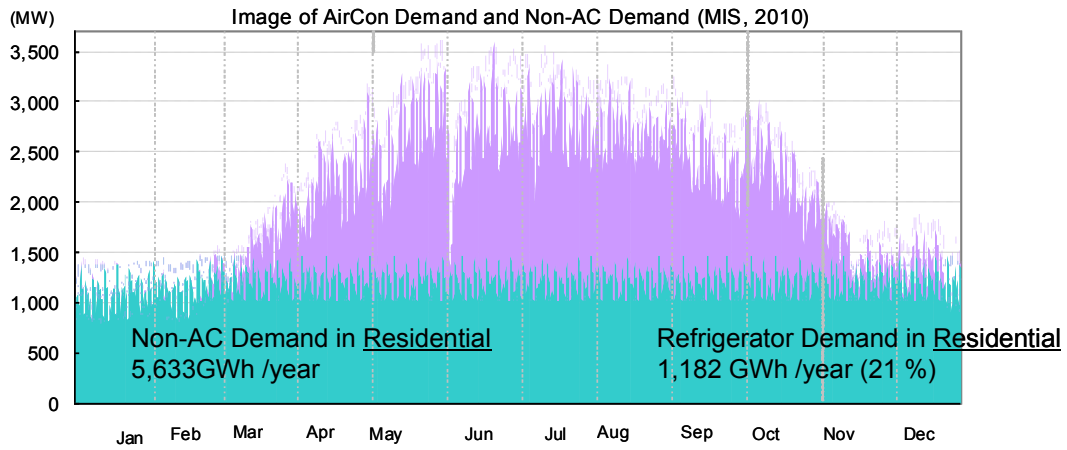


Figure 6- 4 Estimation of Electricity Consumption of Refrigerator in the Residential Sector from MIS's Annual Load Curve (Estimated by JICA Study Team)

(Calculation Result)

- Non-AC demand in the residential sector within MIS in 2010: 5,633 GWh
- Out of which, 21 % of non-AC demand is occupied by the refrigerator's demand (from the data of the Japanese case): 1,182 GWh (=5,633 GWh x 21 %)
- Electricity reduction effect when 10 % of new refrigerators, which can reduce 15 % in electricity consumption, are replaced within MIS in 2011: 17 GWh (= (1,182 GWh x 15 % x 10 %)
- Electricity reduction effect in the whole of Oman: 19 GWh (=17 GWh x 1.14)
- Annual levelized effect assuming 100 % replacements within 10 years: 104 GWh (=19 GWh x 5.5)

(b) Reduction Effect of Peak Demand during Peak Hours

From the following figure (typical daily load curve in the summer within MIS), the refrigerator demand in the residential sector during peak hours (15:00) is assumed to be 135 MW. As a result of the calculation shown below, the annual peak demand reduction effect during the 10 years is calculated at 12 MW.

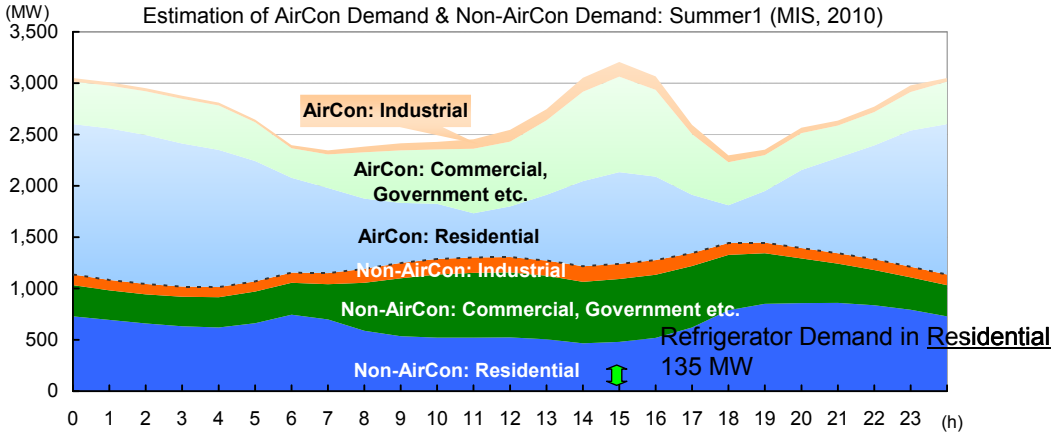


Figure 6- 5 Estimation of Peak Demand of Refrigerator in the Residential Sector from Typical Daily Load Curve in the Summer within MIS (Estimated by the JICA Study Team)

(MW)
Estimation of AirCon Demand & Non-AirCon Demand: Summer2 (MIS, 2010)
3,500
3,000
AirCon: Industrial
2,500
2,000
AirCon: Commercial, Government etc.
1,500
AirCon: Residential

(Calculation Result)

- Refrigerator demand in the residential sector during peak hours within MIS in 2010: 135 MW (= 1,182 GWh/8,760 hrs)
- Reduction effect of peak demand when 10 % of new refrigerators, which can reduce 15 % in electricity consumption, replaced within MIS in 2011: 2.0 MW (= 135 MW x 15 % x 10%)
- Reduction effect of the peak demand in the whole of Oman: 2.3 MW (=2.0 MW x 1.14)
- Annual levelized effect assuming 100 % replacements within 10 years: 12 MW (=2.3 MW x 5.5)

(4) Calculation of the EE&C Effect of Lamp in the Residential, Commercial and Government Sector

(a) Electricity Reduction Effect

From the following figure (MIS's annual load curve), the lamp's demand in the residential, commercial and government sector within MIS is assumed at 2,585 GWh. As a result of the calculation below, the annual electricity reduction effect during 10 years is calculated at 143 GWh.

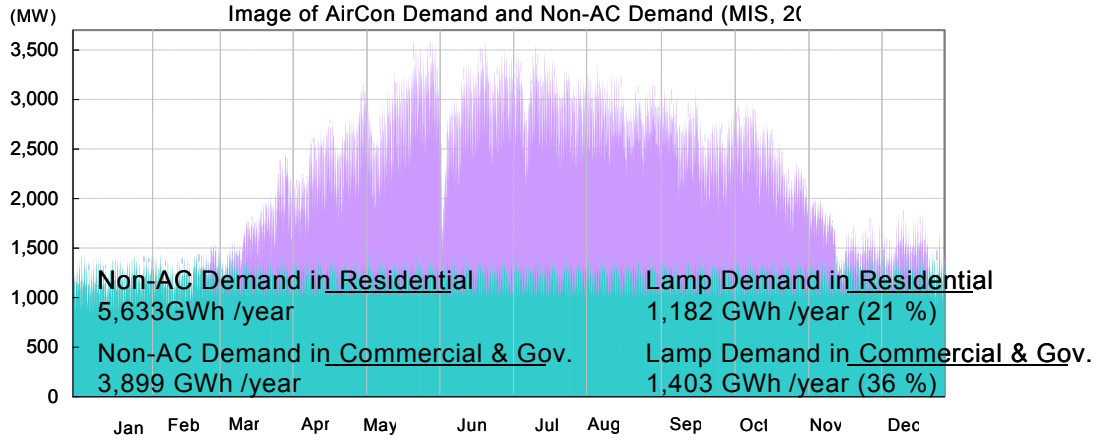


Figure 6- 6 Estimation of Electricity Consumption of Lamp in the Residential, Commercial and Government Sector from MIS's Annual Load Curve (Estimated by JICA Study Team)

(Calculation Result)

- Non-AC demand in the residential sector within MIS in 2010: 5,633 GWh
- Out of which, 21 % of non-AC demand is occupied by the lamp's demand (from the data of the Japanese case): 1,182 GWh (=5,633 GWh x 21 %)
- Non-AC demand in the commercial and government sector within MIS in 2010: 3,899 GWh
- Out of which, 36 % of non-AC demand is occupied by a lamp's demand (from the data of the Japanese case): 1,403 GWh (=3,899 GWh x 36 %)
- Electricity reduction effect when 10 % of the new lamps, which yields a 10 % improvement in energy efficiency, are replaced in the residential, commercial and

government sector within MIS in 2011: 23 GWh (= (1,182 GWh + 1,403 GWh) – ((1,182 GWh + 1,403 GWh) / 110 %)) x 10 %)

- Electricity reduction effect in the whole of Oman: 26 GWh (=23 GWh x 1.14)
- Annual levelized effect assuming 100 % replacements within 10 years: 143 GWh (=26 GWh x 5.5)

(b) Reduction Effect of Peak Demand during the Peak Hours

From the following figure (typical daily load curve in the summer within MIS), the gap (164 MW) in the commercial and government sector between 5:00 (which is the time that lamps turn off) and 15:00 (which is the time that lamps turn on) is assumed to be the lamp demand in these sectors. As a result of the calculations shown below, the annual peak demand reduction effect during the 10 years is calculated at 9 MW in the commercial and government sector.

On the other hand, given that the peak demand of lamps in the residential sector does not come out at 15:00, it is surmised that the reduction effect of lamps in the residential sector is not related to the peak demand reduction in the whole MIS.

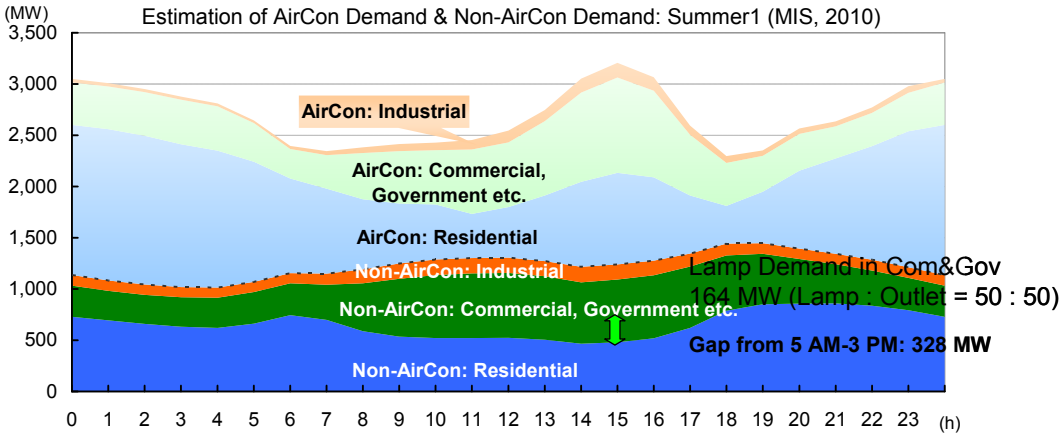


Figure 6- 7 Estimation of Peak Demand of Lamp in the Commercial and Government Sector from Typical Daily Load Curve in the Summer within MIS (Estimated by the JICA Study Team)

(MW) Estimation of AirCon Demand & Non-AirCon Demand: Summer2 (MIS, 2010)

3,000
2,500
2,000
1,500
1,000
500
0
AirCon: Industrial
AirCon: Commercial, Government etc.
AirCon: Residential
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 (h)

(Calculation Results)

- Non-AC demand during peak hours in the commercial and government sector within MIS in 2010: 328 MW
- Out of which, 50 % of non-AC demand is occupied by the lamp's demand (from the data of the Japanese case): 164 MW (= 328 MW x 50 %)
- The reduction effect of peak demand when 10 % of new lamps, which yields a 10% improvement in energy efficiency, are replaced in the commercial and government sector within MIS in 2011: 1.5 MW (= (164 MW / 140 %) x 10 %)
- Reduction effect of peak demand in the whole of Oman: 1.7 MW (=1.5 MW x 1.14)
- Annual levelized effect assuming 100 % replacements within 10 years: 9 MW (=1.7 MW x 5.5)

(5) Summary

The benefits of the Minimum Energy Standards and Labeling System are summarized as follows.

Table 6- 5 Benefits of the Minimum Energy Standards and Labeling System (Summary)

		Electricity Reduction Effect	Reduction Effect of Peak Demand
Expected EE&C Effects in 2011 (Sending point on the generation side)	AC in the Residential Sector	116 GWh	27 MW
	Refrigerator in the Residential Sector	19 GWh	2.3 MW
	Lamp in the Residential, Commercial and Government Sector	26 GWh	1.7 MW
	Total	161 GWh	31 MW
Annual Levelized Effect during 10 Years		885 GWh (= 161 GWh x 5.5)	170 MW (= 31 MW x 5.5)
Monetary Value of the Annual Levelized Effect		88.5 million US$/year	15.3 million US$/year

* 0.10 US$/kWh、90 US$/kW/year

6.2.3 EE&C Building Regulation

(1) Assumption for the Calculation of Benefits

Assumption for the benefit calculation is described below.

- It is assumed that 50 % of existing houses and buildings are gradually replaced satisfying the EE&C Building Regulation within 20 years (annually 2.5 % replacement).
- Based on the MIS annual load curve in 2010 obtained from OETC, a sector-wise power demand breakdown was estimated. Utilizing the estimated power demand breakdown, the reduction effects of AC's electricity consumption by improving insulation are calculated. The load curve is represented via a net production (that is electricity at the sending points on the generation side).
- The electricity reduction effects in the whole of Oman is obtained by the calculated MIS's effect multiplied by 1.14 times in consideration of the proportion of the electricity sales record of MIS and other areas (MIS:DPC:RAECO = 100:11:3).

(2) Calculation of the EE&C Effects in the Residential Sector

(a) Electricity Reduction Effect

From the MIS's annual load curve as previously shown, AC's demand within the residential sector is assumed. As a result of the calculation, the annual electricity reduction effects over a 20-year period is calculated at 367 GWh.

(Calculation Results)

- AC demand in the residential sector within MIS in 2010: 4,420 GWh
- Electricity reduction effect when 2.5 % of new houses, which have enough insulation

satisfying the regulation, replaces and reduces 28 % of electricity consumption within MIS in 2011: 31 GWh (= 4,420 GWh x 2.5 % x 28 %)

- Electricity reduction effect in the whole of Oman: 35 GWh (=31 GWh x 1.14)
- Annual levelized effect assuming 50 % replacements within 20 years: 367 GWh (=35 GWh x 10.5)

(b) Reduction Effect of Peak Demand during Peak Hours

From the MIS's typical daily load curve in the summer as previously shown, the AC demand in the residential sector during peak hours (15:00) is assumed to be 1,036 MW. As a result of the calculation shown below, the annual peak demand reduction effect over a 20-year period is calculated at 86 MW.

(Calculation Results)

- AC demand in the residential sector during peak hours within MIS in 2010: 1,036 MW
- Reduction effect of peak demand when 2.5 % of new houses, which have enough insulation satisfying the regulation, replaces and reduces 28 % of electricity consumption within MIS in 2011: 7.2 MW (= 1,036 MW x 2.5 % x 28 %)
- Reduction effects of the peak demand in the whole of Oman: 8.2 MW (=7.2 MW x 1.14)
- Annual levelized effect assuming 50 % replacements within 20 years: 86 MW (=8.2 MW x 10.5)

(3) Calculation of EE&C Effects in the Commercial and Government Sector

(a) Electricity Reduction Effect

From the following figure (MIS's annual load curve), the building's AC demand in the commercial and government sector within MIS is assumed to be 2,444 GWh. As a result of the calculation below, the annual electricity reduction effect over a period of 20 years is calculated at 178 GWh.

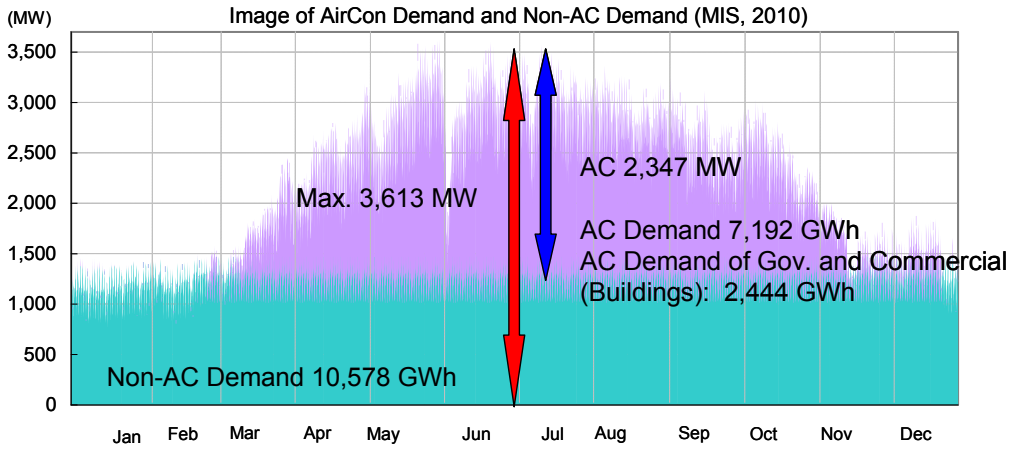


Figure 6- 8 Estimation of Electricity Consumption of Building ACs in the Commercial and Government Sector from MIS's Annual Load Curve (Estimated by JICA Study Team)

(Calculation Results)

- Building AC demand in the commercial and government sector within MIS in 2010: 2,444 GWh
- Electricity reduction effect when 2.5 % of new buildings, which have enough insulation to satisfy regulations, replaces and reduces 25 % of electricity consumption within MIS in 2011: 15 GWh (= 2,444 GWh x 2.5 % x 25 %)
- Electricity reduction effect in the whole Oman: 17 GWh (=15 GWh x 1.14)
- Annual levelized effect assuming 50 % replacements within 20 years: 178 GWh (=17 GWh x 10.5)

(b) Reduction Effect of Peak Demand during Peak Hours

From the following figure (the typical daily load curve during the summer within MIS), the building's AC demand in the commercial and government sector during peak hours (15:00) is assumed to be 1,137 MW. As a result of the calculation shown below, the annual peak demand reduction effect over a 20-year period is calculated at 94 MW.

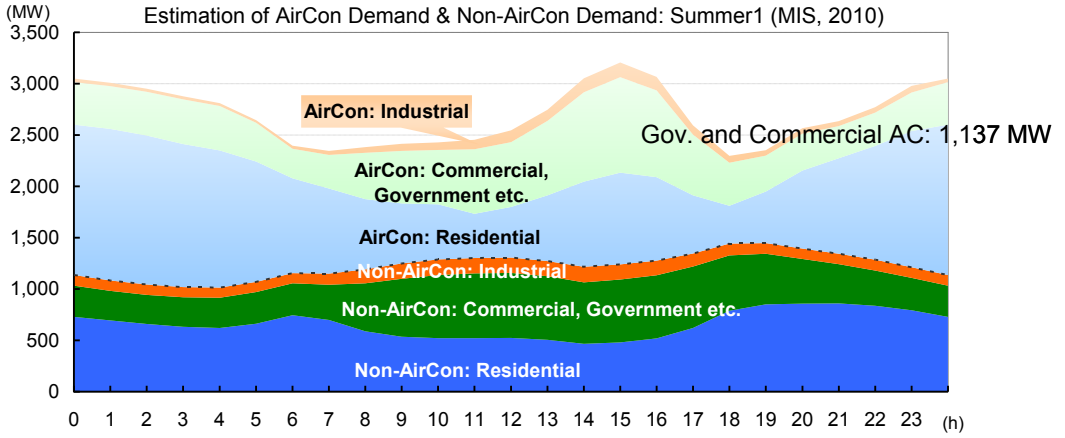


Figure 6- 9 Estimation of Peak Demand of Building ACs in the Commercial and Government Sector from Typical Daily Load Curve in the Summer within MIS (Estimated by the JICA Study Team)

(MW)
Estimation of AirCon Demand & Non-AirCon Demand: Summer2 (MIS, 2010)
3,500
3,000
2,500
2,000
1,500
1,000
500
0
AirCon: Industrial
AirCon: Commercial, Government etc.
AirCon: Residential
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 (h)

(Calculation Result)

- Building AC demand in the commercial and government sector during peak hours within MIS in 2010: 1,137 MW
- Reduction effect of peak demand when 2.5 % of new buildings, which have enough insulation satisfying the regulation, were replaced and achieved a 25% reduction in electricity consumption within MIS in 2011: 7.1 MW (= 1,137 MW x 2.5 % x 25 %)
- Reduction effect of peak demand in the whole Oman: 8.1 MW (=7.1 MW x 1.14)
- Annual levelized effect assuming 50 % replacements within 20 years: 8.1 MW (=9.0 MW x 10.5)

(4) Summary

The benefits of the EE&C Building Regulation are summarized as follows.

Table 6- 6 Benefits of the EE&C Building Regulation (Summary)

		Electricity Reduction Effect	Reduction Effect of Peak Demand
Expected EE&C Effects in 2011 (Sending point on the generation side)	ACs in the Residential Sector	35 GWh	8.2 MW
	Building ACs in the Commercial and Government Sector	17 GWh	8.1 MW
	Total	52 GWh	16.3 MW
Annual Levelized Effect during 20 Years		546 GWh (= 52 GWh x 10.5)	171 MW (= 16.3 MW x 10.5)
Monetary Value of the Annual Levelized Effect		54.6 million US$/year	15.4 million US$/year

* 0.10 US$/kWh、90 US$/kW/year

6.2.4 DSM Tariff System

(1) Assumption in Calculation of Benefits

In estimating the benefits of implementing the TOU tariff, this Study first sets a hypothesis of the diffusion scenario of the TOU tariff, tests this hypothesis by referring to past experience in Japan, and then, based on the parameters obtained from this, formulates a peak shift effect when the TOU tariff is implemented in Oman.

< Methodologies of Evaluating the Peak Shift Effect of the TOU Tariff >

- TOU tariff sets different unit rates among time zones to motivate the customers' voluntary peak shift.
- The customers' behaviour to shift their peak demand in response to the price signal set out in the TOU tariff varies according to the case, thus it is difficult to standardize the expected peak shift for each individual customer. For example, those customers whose load factor is originally high may only enjoy the benefits of reduced billing of the TOU tariff without any further peak shift efforts. On the other hand, there may also be customers who try to change their load pattern as much as possible to gain the maximum benefit from the TOU tariff.
- Therefore, it is more appropriate to take a macro approach, i.e. how much the load factor of the entire sector improves with the customers' shift over to a TOU tariff, than to try a micro approach to estimate the TOU tariff's effect on individual customers.

< Diffusion Scenario of the TOU Tariff >

- As a general trend, a newly implemented DSM tariff like the TOU is first adopted by those customers whose load factor is high, who will surely benefit without further load factor improvement efforts, and then gradually followed by those customers whose load factor is lower.

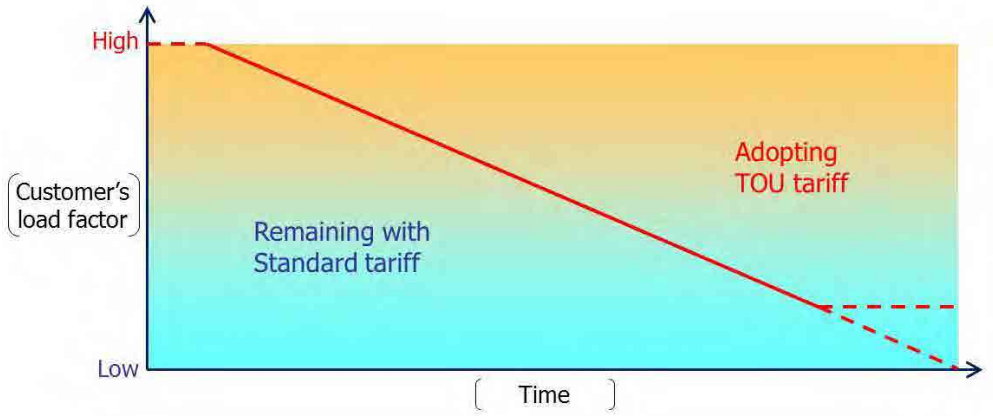


Figure 6- 10 Diffusion Scenario of the TOU Tariff (image)

- In this process, the average load factor of those customers who choose TOU gradually decreases with the new addition of customers whose load factor is lower than existing TOU customers. In the meanwhile, the average load factor of non-TOU customers also gradually decreases with the departure of customers whose load factor is relatively high within this group. However, the average load factor of the entire sector, i.e. the total of these two groups, gradually increases due to some customer efforts to improve their own load factor.
  [Note: If the TOU customers only enjoy the benefit of reduced billing without efforts to improve their own load factor, the average load factor of the entire sector becomes constant regardless of the percentage of TOU customers.]
- Therefore, the improvement in the entire sector's average load factor in relation to the percentage of TOU customers can be interpreted as the peak shift effect of the TOU tariff.

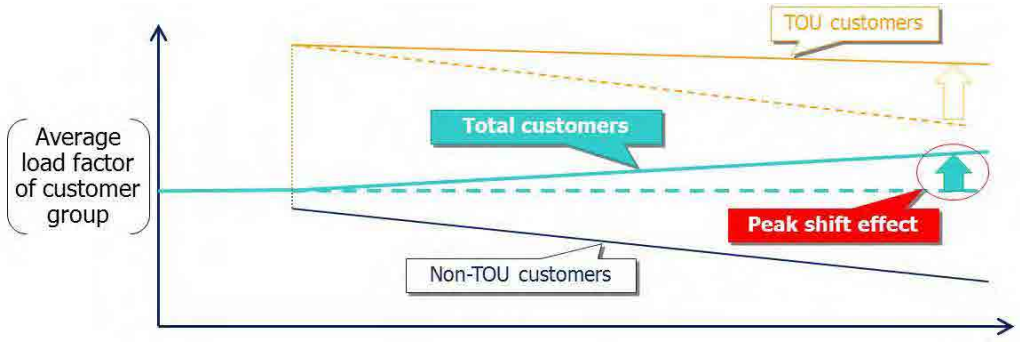


Figure 6- 11 Evaluation of the Peak Shift Effect with the Diffusion of the TOU Tariff (Image)

- In the early 2000's in Japan, there was a massive migration of large industrial and commercial customers from the standard tariff to DSM tariffs like the TOU, which is due to strong encouragement from power utilities that wanted to retain the favored customers in the retail market liberalization. A correlation was observed during this period that the average load factor of the industrial and commercial sectors improved by about 0.06 % and 0.04 % respectively as the customers in both sectors shifted to

DSM tariffs by 1 %.

- This Study assumes that the same peak shift effect will be expected in the industrial sector (factories) and "commercial, government etc." sector (buildings) in Oman by implementing the TOU tariff, disregarding the difference in the structure of the TOU tariff rates and the price elasticity of power demand between these two countries. That is, when all the customers in these two sectors shift to the TOU tariff, the average load factor of factory and building power demand will improve by 6 % and 4 % respectively.
- When the TOU tariff is presented as an optional tariff, the customers with a relatively low load factor will prefer to remain with the current "Standard Tariff". Here, this Study assumes that a little more than the half (60 %) of the customers in both sectors will shift to the TOU tariff.

< Targeted Area and Customers >

- The target is confined to customers in the industrial sector (factories) and the "commercial, government etc." sectors (buildings), to whom the power is supplied from the MIS grid.
- The potential of the peak shift effect with the TOU tariff in the Salalah area is supposed to be trivial, as also discussed in 5.7.4. In the Salalah area, where the total power demand is as small as less than 10 % of that in the MIS area, the load fluctuation in a day is relatively small even during the high-load season during the summer, due to the difference in weather conditions from northern Oman like Muscat, thus the possibility of the load shift from daytime peak hours to off-peak hours is limited. Moreover, the Salalah area is the highest load recorded during the nighttime peak hours, when the residential sector accounts for a large share, thus even if the factories and buildings successfully reduce their power demand during daytime peak hours, this does not contribute to the load factor improvement of the total Salalah grid.

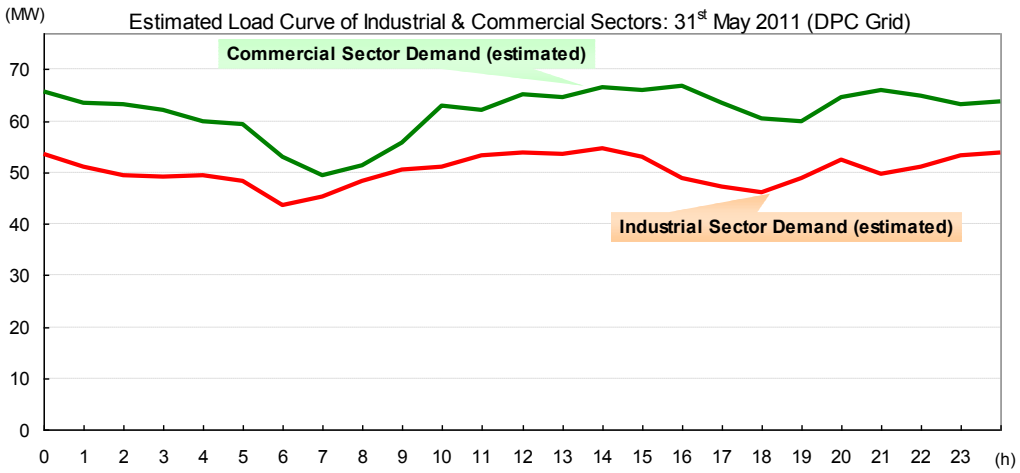


Figure 6- 12 The Estimated Daily Load Curve of the Industrial Sector and the Commercial, Government etc. Sector in Salalah Grid on the Day of Annual Peak Load in 2011 (31st May)

- This Study considers that the peak shift effect of the TOU tariff in the RAECO area does not need to be considered. Its total demand is still smaller and the share of factories and buildings, i.e. the eligible customers of the TOU tariff, in the total power demand is also smaller than in the MIS and DPC areas.

(2) Results of Estimating the Peak Load Reduction in the Industrial Sector

The Study Team estimates that the industrial sector's share in the annual peak load of the MIS grid in 2010 (15 ^{h}, 1st June: 3,613 MW) was 325 MW. If 60 % of this industrial demand had adopted the TOU tariff, the peak load would have been reduced by 3.6 % (= 60 % x 6 %), which is 11.7 MW (= 325 MW x 3.6 %).

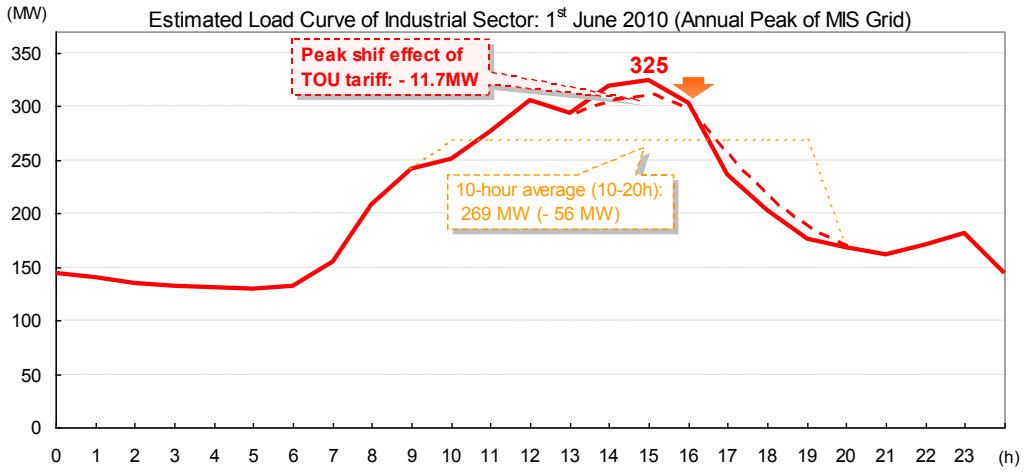


Figure 6- 13 The Estimated Daily Load Curve of the Industrial Sector in the MIS Grid on the Day of Annual Peak Load in 2010 (1st June)

Assuming that the industrial sector's load during the daytime peak hours (3 hours between the 14^{h} and 17^{h}) shifts to the preceding and following off-peak hours and that the load becomes totally flat for 10 hours from 10 ^{h} to 20 ^{h}, the average load during these hours would have become 269 MW and the peak load would have been reduced by 56 MW. However, this assumption of load leveling is too unrealistic and it is justified to estimate the peak reduction at 11.7 MW, which is about 20 % of this, as a result of the customers' voluntary efforts to respond to the price incentive.

(3) Results of Estimating the Peak Load Reduction in the Commercial, Government etc. Sector

The Study Team estimates that the "commercial, government etc." sector's share in the annual peak load of the MIS grid in 2010 was 1,777 MW. In the same way, if 60 % of this demand had adopted the TOU tariff, the peak load would have been reduced by 2.6 % (= 60 % x 4 %), which is 42.7 MW (= 1,777 MW x 2.4 %).

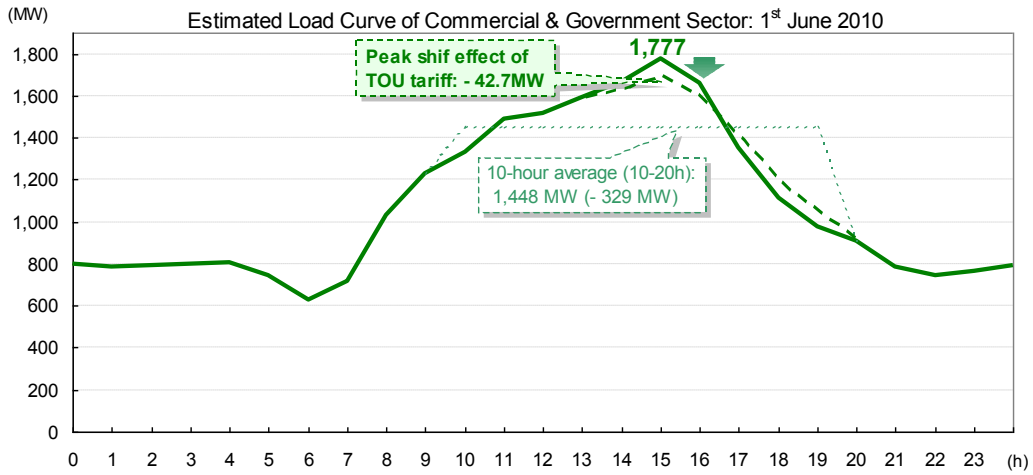


Figure 6- 14 The Estimated Daily Load Curve of the Commercial, Government etc. Sector in MIS Grid on the Day of Annual Peak Load in 2010 (1st June)

Assuming that this sector's load during the daytime peak hours (3 hours between 14h and 17h) shifts to the preceding and the following off-peak hours and that the load becomes totally flat for 10 hours from 10 h to 20 h, the average load during these hours would have become 1,448 MW and the peak load would have reduced by 329 MW. Considering the price elasticity of this sector, which is by nature lower than that of the industrial sector, it is justified to estimate the peak reduction at 42.7 MW, which is a little more than 10 % of this, as the result of the customers' voluntary efforts to respond to the price incentive.

(4) Economic Value of the Peak Load Reduction

In total, the effect of the peak load reduction by implementing the TOU tariff for the industrial and commercial, government etc. sectors is estimated to be 54.4 MW as of 2010.

The expected avoidable costs related to the new addition of power supply facilities is estimated to be about 4.9 million US$.

(Results of the Calculation)

- Reduced capital investment: 43.5 million US$ (= 54.4 MW x 800 US$/kW)
- Reduction of depreciation costs per year (linear depreciation for 16 years): 2.72 million US$/year (= 43.5 / 16)
- Reduction of other O&M costs per year (40 US$/kW: 5 % of the capital expenditure): 2.17 million US$/year (= 54.4 MW x 40 US$/kW)
- Reduction of total costs per year: 4.89 million US$/year (= 2.72 + 2.17)

6.2.5 Smart Meters

(1) Assumption of the Calculation of Benefits

Assumption for the benefit calculation is described below.

- It is assumed that smart meters will be 100 % replaced in all of the residential houses within 1 year after the start of installation.

- Based on the MIS annual load curve in 2010 obtained from OETC, a sector-wise power demand breakdown was estimated. Utilizing the estimated power demand breakdown, the electricity reduction effects via a visual breakdown are calculated.
- The electricity reduction effects in the whole of Oman is obtained by the calculated MIS's effect multiplied by 1.14 times considering the proportion of electricity sales record of MIS and other areas (MIS:DPC:RAECO = 100:11:3).

(2) Calculation of the EE&C Effect of AC in the Residential Sector (Electricity Reduction Effect)

As a result of the following calculation using the above assumption, the annual electricity reduction effect is estimated to be 58 GWh. The monetary value converted from this effect is calculated at 5.8 million US$/year.

(Calculation Result)

- Annual electricity consumption in the residential sector within MIS in 2010: 10,053 GWh (=4,420 GWh (AC) + 5,633 GWh (Non-AC))
- The electricity reduction effect assuming that 68 % of customers will have a cooperative will for energy saving actions, 41.7 % customers have an internet system, and 1.8 % reduction effect is expected per having access to a visual breakdown: 51 GWh (= 10,053 GWh x 41.7 % x 68.1 % x 1.8 %)
- Electricity reduction effect in the whole of Oman: 58 GWh (=51. GWh x 1.14)
- Annual levelized effect: 58 GWh

(3) Increase of Financial Benefits (Reference)

Smart meters can expect not only EE&C effects but also an increase of financial benefits for power utilities. For reference, the effect on financial benefits is estimated as follows. As a result of the following calculation, a 30 RO/year is expected as the financial benefits per customer. Thus by assuming an investment cost for smart meters at 120 RO per customer, it can recover costs within 4 years.

(Assumption)

- Total sales revenue in the whole of Oman in 2010: 16,132 GWh
- Total number of customers in the whole of Oman in 2010: 677,688 customers
- Multi-functions of smart meters (protection of power theft, correction of meter reading error, etc.) can contribute to the reduction of non-technical losses from 8 % to 1 %.
- Average tariff: 15 Bz/kWh
- Meter reading cost: 5 RO/customer

(Calculation Results)

- Reduction of non-technical losses: 16,938,600 RO (= 15 Bz/kWh x 16,132 GWh x 7 %)
- Reduction of meter reading costs: 3,388,440 RO (= 5 RO/customer x 677,688 customers)
- Financial benefits per customer: 30 RO (= (3,388,440 RO+16,938,600 RO) / 677,688 customers)

6.3 Results of the Discussion on the Priority Screening

6.3.1 Analysis of Costs and Benefits

(1) Expected EE&C Effects

Regarding each EE&C Measure, annual levelized effects are summarized as follows.

Table 6- 7 EE&C Effects of Each EE&C Measure (Annual Levelized Effects)

	Energy Reduction Effect	Reduction Effect of Peak Demand	Monetary Value of Annual Levelized Effect
Energy Management System	148 ktoe + 110 GWh (69 million US$/year)	-	69 million US$/year
Minimum Energy Standards and Labeling System	885 GWh (88.5 million YS$/year)	170 MW (15.3 million US$/year)	104 million US$/year
EE&C Building Regulation	546 GWh (54.6 million US$/year)	171 MW (15.4 million US$/year)	70 million US$/year
DSM Tariff System (TOU Tariff System)	-	54.4 MW (4.9 million US$/year)	4.9 million US$/year
Smart Meter (Visualization Function)	58 GWh (5.9 million US$/year)	-	5.9 million US$/year

* Electricity value (GWh and MW) is represented at sending points in a generation side.

(2) Results of Cost and Benefit Analysis

To evaluate the priority of each EE&C measure, a cost and benefit analysis is conducted as follows. The expected costs using in the analysis are represented by the ranges of the cost level to grasp a rough order of priority.

Table 6- 8 Results of Cost and Benefit Analysis (Rough Estimation)

	Monetary Value of Annual Levelized Effect	Expected Cost Range*1	Technical Difficulty in Scheme Design	Evaluation
Energy Management System	69 million US$/year	Administration Cost: S Investment Cost: S-L	Medium - Hard	High
Minimum Energy Standards and Labeling System	104 million US$/year	Administration Cost: S Investment Cost: L	Medium	High+
EE&C Building Regulation	70 million US$/year	Administration Cost: S Investment Cost: L	Medium - Hard	High+
DSM Tariff System (TOU Tariff System) *2	4.9 million US$/year	Administration Cost: “0” Investment Cost: “0”	Medium	Fair
Smart Meter (Visualization Function) *2	5.9 million US$/year	Administration Cost: “0” Investment Cost: “0”	Easy - Medium	Fair

*1: Cost is defined as an incremental cost to obtain EE&C effect. The cost ranges are defined as follows.
“0”: Almost zero
S: Small (Not more than 1 mission US$/year)
M: Middle (1 mission US$/year - 10 mission US$/year)
L: Large (More than 10 mission US$/year)

*2: EE&C effects by TOU tariff system and visualization function are realized by smart meters. Assuming smart meters can be financially justified by the financial benefits such as reduction of non-technical loss and reduction of meter reading cost, the investment cost of smart meter does not consider into the above analysis, and only the cost for incremental function for TOU tariff and visualization is considered into the analysis.

6.3.2 Basic Principle for Design of Framework of Each EE&C Measure

(1) Results of the Discussion on the Priority Screening

The JICA Study Team proposed the results of cost and benefit analysis and the Working Committee agreed upon the results.

(2) The Basic Principle for the Design of the Framework of each EE&C Measure

Through the discussion with the Working Committee, the basic principle for designing the framework of each EE&C measure was confirmed as follows.

Energy Management System

The framework for this scheme is further discussed in the Study. Both electricity and fuel are considered for the framework design.

Minimum Energy Standards and Labeling System

The framework for this scheme is further discussed as a priority scheme in the Study.

EE&C Building Regulation

The framework for this scheme is further discussed as a priority scheme in the Study.

DSM Tariff System

The TOU tariff system considers targeting the commercial and government sector. Besides, based on a discussion with the Working Committee, another tariff system, the "Load Adjustment Contract (Summer Operation Adjustment Contract)", is also discussed in the Study.

Smart Meters

The visualization of electricity consumption is based on the installation of smart meters. The EE&C effects of the visual breakdown in Oman is verified and the financial feasibility of installing a smart meter is also studied in terms of the reduction of non-technical losses and the reduction of meter reading costs, etc.

Chapter 7 Framework Design for Each EE&C Measure

7.1 Methodology

7.1.1 Formation of Sub-Committee for Discussion

Five measures evaluated in the priority screening in the previous chapter and another program (EE&C Dissemination Program) are discussed for studying the framework design at Sub-Committees which are formulated by gathering relevant agencies related to each measure.

Relevant agencies are grouped into 6 Sub-Committees to discuss the framework as follows. The results of the discussion in each Sub-Committee are finally approved by the Working Committee.

	Members
Sub-Committee 1 (Energy Management System)	PAEW, MOCI (Ministry of Commerce and Industry), MOG (Ministry of Oil and Gas), MECA (Ministry of Environment and Climate Affairs), OETC, RAECO
Sub-Committee 2 (Minimum Energy Standard and Labeling System)	MOCI, MZEC, MJEC
Sub-Committee 3 (EE&C Building Regulation)	PAEW, MM (Muscat Municipality), MEDC
Sub-Committee 4 (DSM Tariff Program & Smart Meter)	PAEW, AER, EHC, OPWP, MEDC, MJEC, MZEC, RAECO
Sub-Committee 5 (Street Lighting)	PAEW, MM, MRMWR (Ministry of Regional Municipalities and Water Resources)
Sub-Committee 6 (EE&C Dissemination Program)	PAEW, MECA, EHC, MEDC, MJEC, MZEC, MEDC

Figure 7- 1 Members for Each Sub-Committee

7.1.2 Basic Principle for Design

This is a master plan study which does not include a detailed design for each measure. In the framework design, mandatory programs such as the Energy Management System, Minimum Energy Standard and Labeling System, and the EE&C Building Regulation are basically discussed for the implementation formation, obligation and rights, definition and regulations.

On the other hand, voluntary programs such as the DSM Tariff System, Smart Meter, and EE&C Dissemination Program have already been partially implemented or planned in Oman. In this context, these programs are basically discussed refinement and improvement methods.

Based on the above discussion, the implementation formation, the roles of each player, the target sector/target equipment, the range of effects of each measure, the estimation of implementation costs, etc. are identified. These factors can be the judgment criteria to determine whether each measure is beneficial or not for the country.

7.2 Energy Management System

7.2.1 Design Items for Scheme Framework

A framework design for the scheme is discussed via 2 steps, namely a primary step for fundamental design items (implementation formation, target sector, etc.) and a secondary step for supplementary design items (designation of targets, inspections, penalties, etc.). This is because the secondary step can proceed after the finalization of the fundamental design items in the primary step.

With regard to the scheme for the Energy Management System, it was confirmed that the following design items were discussed.

(Fundamental Design Items)

- Target Energy and Implementation Formation
- Target Sector
- Necessity of the Energy Manager
- Necessity of the Mandatory Energy Audit

(Supplementary Design Items)

- Selection of Designated Consumers
- Boundary for Management Area
- Qualification and Training System for Energy Manager and Energy Auditor, etc.
- Contents of Periodical Report
- Evaluation methods of inappropriate energy conservation activities and their penalties

7.2.2 Discussion Results of Each Design Item

(1) Discussion on Fundamental Design Items

(a) Target Energy and Implementation Formation

The item on the target energy discusses what energy types are managed by the scheme. A regulatory body is decided in accordance with the energy types to be managed by the scheme.

As a result of the discussion with the Sub-Committee, the following 2 options were raised. Thus both options are described below.

Option 1: Management for only electricity

Option 2: Management for both electricity and fuel

In case Option 2 is selected, an agreement of the Ministry of Oil and Gas (MOG) and Ministry of Commerce and Industry (MOCI), which is a responsible body for fuel matters, is required.

In this item, the JICA Study Team recommended Option 2 (Both electricity and fuel) because fuels were more influenced by energy efficiency in terms of caloric value and in general energy consumers did not make a distinction between electricity efficiency and energy efficiency on their sites.

Assuming the selection of Option 2, the following items related to this design item were confirmed to be a final proposal.

- Energy to be managed is primary energy and the Btu unit is used. GHG emissions calculation is also included. The data for GHG emissions is sent to the Ministry of Environment and Climate Affairs (MECA) as well.
- In order to avoid redundant procedures, periodical reports from designated consumers are to be submitted to a One-Stop Agency (a regulatory body). This agency appraises and checks the periodical reports and performance of the organizations and then reports the evaluation results to the Steering Committee (PAEW, MOG, MOCI, MECA, etc.) as a higher authority.
- Within the agency, “Technical Evaluation Committee” is to be established to consult technical matters.

(b) Target Sector

This item discusses which sector should be covered by the scheme. As a result of the discussion with the Sub-Committee, it was finally proposed that the industrial sector including the transformation sector such as power plants, oil refineries, etc., the commercial sector and the government sector would be the target sectors. Especially, the government sector is to be a priority sector because the government sector must initiate EE&C actions to the public.

(c) Necessity of an Energy Manager

An Energy Manager is defined as the responsible person on site for energy management for designated consumers. The item discusses the necessity of Energy Manager for designated

consumers.

As a result of the discussion with the Sub-Committee, it was finally proposed that an Energy Manager was to be assigned as the responsible person who was certified via a national qualification system, and registered on behalf of the designated consumer. Besides, the following points relating to the item were confirmed to be a final proposal.

- An Energy Manager certified via a national qualification system compiles a "Periodical Report" including an EE&C Plan and initiates EE&C actions. The national qualification system is executed by an agency (university, training center, etc.) which is authorized by the competent Ministry.
- For a factory site, an Energy Manager is to be stationed on site. However, in general, there are few energy management engineers in the buildings. Thus, for a building site, it is acceptable that the roles of Energy Manager are outsourced to an external consultant.
- In those cases where Energy Managers have been outsourced to buildings, it is required to have a permanent Energy Officer as a supporter for the outsourced Energy Manager to create a periodical report and promote EE&C actions where he/she is to be stationed.

(d) Necessity of a Mandatory Energy Audit

The item discusses whether a mandatory energy audit conducted by Energy Auditor(s) (external consultant) will be adopted for designated consumers or not.

As a result of the discussion with the Sub-Committee, it was finally proposed that an energy audit conducted by a skilled energy auditor is effective for supporting the Energy Manager's activities. It was further proposed that, in order to provide incentives to promote the acceptance of the energy audit, the Government should provide some subsidies to cover the cost of energy audit.

Besides, the following points relating to the item were confirmed to be a final proposal.

- Results of the energy audit conducted by national qualified Energy Auditor(s) are sent to the designated consumer as well as the regulatory body to judge whether proper management is conducted or not. The national qualification system for the Energy Auditor is executed by an agency (university, training center, etc.) which is authorized by a competent Ministry.
- Private engineering companies, distribution companies, etc. are expected for organizations who conduct a mandatory energy audit.
- The mandatory energy audit is expected to be conducted once in 3 years.

(2) Discussion on Supplementary Design Items

(a) Selection of Designated Consumers

In the primary step of the discussion, the industrial, commercial and government sectors were confirmed to be covered by the scheme. The item discusses how to select designated consumers from these sectors. As a result of the discussion with the Sub-Committee, it was finally proposed that thresholds for each sector should be set up respectively.

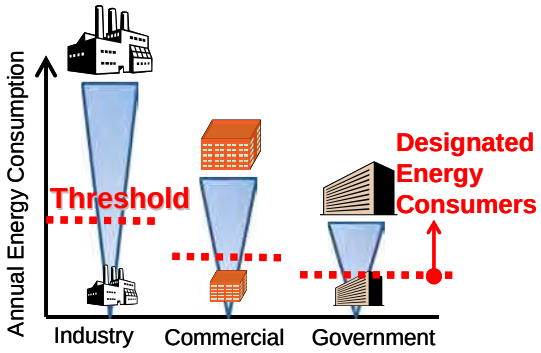


Figure 7- 2 Selection of Designated Consumers (Image)

Besides, the following points related to the item were confirmed to be a final proposal.

- An appropriate number of designated consumers (about 300) should be considered to match to human resources and for the work efficiency in the scheme.
- The thresholds for each sector are assumed as follows from the results of the "Energy Consumption Analysis by Site" in 5.6.

Table 7- 1 Thresholds for Each Sector (Tentative)

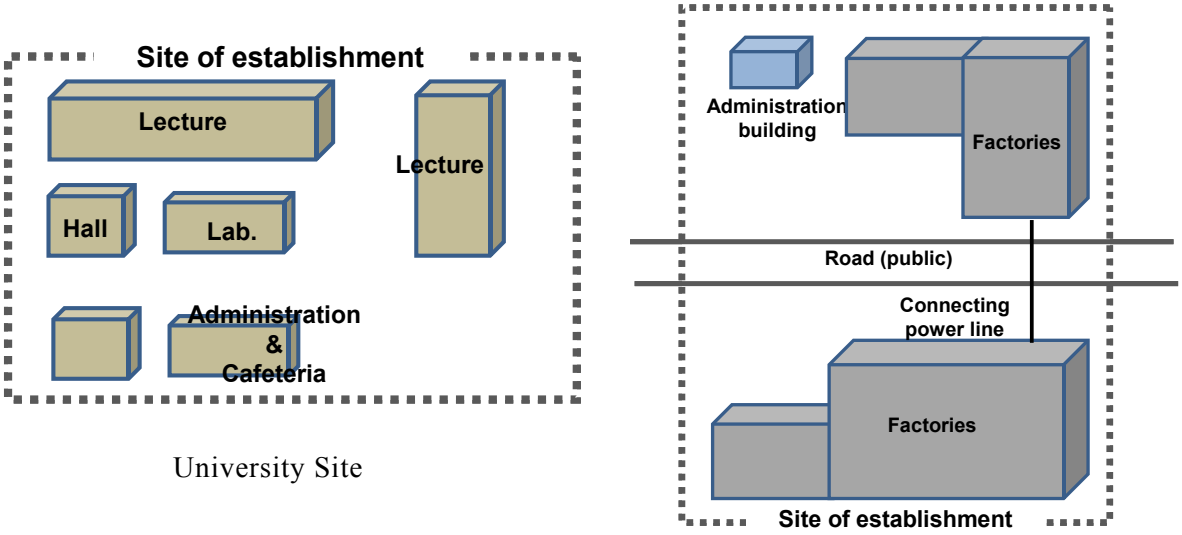
	Threshold (Annual Energy Consumption: Primary Energy Equivalent)	Coverage Ratio in Energy Consumption	Expected Number of Designation Site
Industrial Sector	60,000 MMBtu	91 %	60
Commercial Sector	50,000 MMBtu	58 %	110
Government Sector	50,000 MMBtu	68 %	150
		Total	320

(b) Boundary for the Management Area

The item discusses the management area, by organization or by site, in the scheme. As a result of the discussion with the Sub-Committee, it was finally proposed that management by site be selected because the data collection system was relatively easy to establish in the beginning stages of the scheme. Assuming that the whole organization is managed, it might be difficult to collect from all the buildings including the small structures.

Besides, the following points relating to the item were confirmed to be a final proposal.

- In case that one owner holds multiple buildings or factories, and the energy supply system of these buildings and factories are connected with each other, the buildings and factories are to be regarded as one site (ex. Universities, factories in the same location, etc.).

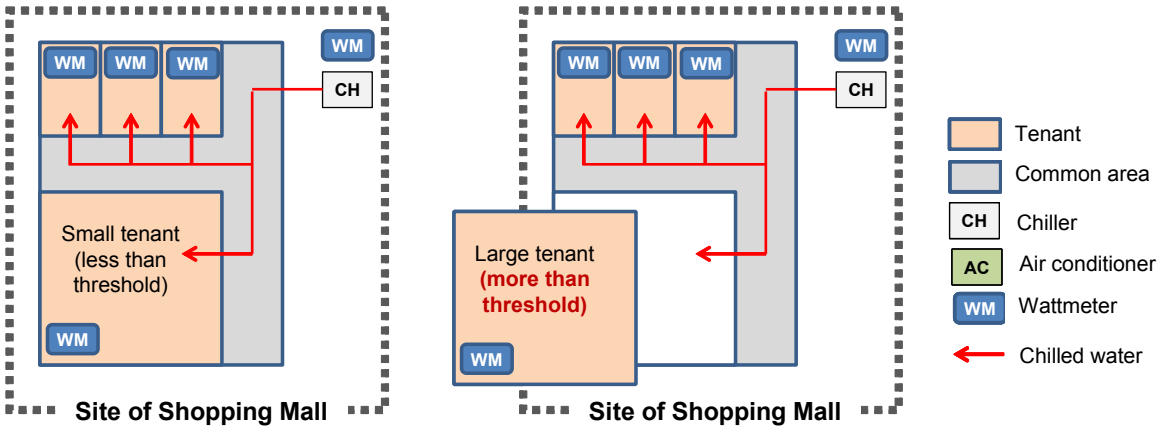


University Site

Factory Site

Figure 7- 3 Samples which are Regarded as One Site

- In the case for a building having multiple tenants, there are 2 options for the designation method, namely an option that a whole building including a building operator and all the tenants is designated, and another option that a building operator and each tenant are respectively selected as a designated consumer by the threshold. With regard to this case, because it is not known how many cases exist in a whole country, the final proposal was not made in the Study.



Option that a Whole Building including a Building Operator and All the Tenants is Designated

Option that a Building Operator and Each Tenant are Respectively Selected as a Designated Consumer by the Threshold

Figure 7- 4 Options for Designation in the Case of a Building Having Multiple Tenants

(c) Qualification and Training System for the Energy Manager and Energy Auditor, etc.

The item discusses the qualification system for the Energy Manager (and Energy Officer in case an Energy Manager is outsourced) and the Energy Auditor for the mandatory energy audit.

As a result of the discussion with the Sub-Committee, it was finally proposed as follows.

- This status is certified via a national qualification system
- Energy Manager is certified via a national training course with a certificate examination.
- An Energy Auditor is certified via a national training course.
- An Energy Officer is certified via a national training course

Besides, these national training courses are executed by an agency which is authorized by a competent government body. The licenses, which are obtained after getting the certificates, set up validity periods (3 to 5 years). For extension of the licenses, the licensees should take simple training courses to update their skills.

The certification methods for the Energy Manager and Energy Auditor are proposed as follows.

(i) Qualification Method for the Energy Manager

The following 3 courses are proposed for the qualification method that is selected by applicants.

Table 7- 2 Courses of Qualification Method for Energy Manager

	Course 1	Course 2	Course 3
Pre-condition 1	Bachelor in science & engineering	Diploma in science & engineering	Graduation certificate of institute or Company authorization as an engineer
Pre-condition 2	More than 1 year experience in planning, operation and maintenance in energy management	More than 3 years experience in planning, operation and maintenance in energy management	More than 5 years experience in planning, operation and maintenance in energy management
Qualification Methods	National training course with certificate examination		

(ii) Qualification Method for Energy Auditor

It was finally proposed that the applicants for Energy Auditor should satisfy the following pre and post conditions and take a national training course in order to be certified.

- Pre-condition: Having an Energy Manager License
- Post-condition: Having about 3 energy audit experience jointly conducted with energy audit experts who have rich experience

(d) Contents of the Periodical Report

This item discussed the contents of the Periodical Report submitted by the designated consumers (sites) once a year. As a result of the discussion with the Sub-Committee, it was finally proposed that the “Energy Consumption Calculation Sheet” including the calculation sheet for GHG emissions, the “Equipment List”, “Energy Intensity Calculation Sheet and Historical Record”, and “EE&C Plan” were included in the report.

The following figures show the samples of the reporting formats proposed by the JICA

Study Team. The formats are created assuming the scheme adopts the monitoring of both electricity and fuel. In case the scheme adopts management for only electricity, the necessary information columns should be picked up from the formats.

Table 7- 3 Format 1: Energy Consumption Calculation Sheet

Annual energy consumption and GHG emission FY 2011

Type of energy		Unit	Annual quantity	Primary energy		Greenhouse gas emission	
				Conversion factor	Quantity [MMBtu]	Conversion factor	Quantity [t-CO2]
Electricity	Purchased electricity	kWh	22,000,000	0.00341	75,020	***	****
Fuels	Crude oil	kl		***		***	
	Gasoline	kl		***		***	
	Kerosene	kl		***		***	
	Diesel oil	kl		***		***	
	Fuel oil	kl		***		***	
	Natural gas	Nm^3	83,400,000	0.0375	3,127,500	***	
	LPG	Nm^3		***		***	
	*****	**		***		***	
	*****	**		***		***	
Total Energy Consumption [MMBtu]					3,202,520		****
Total Energy Consumption in Previous FY [MMBtu]					3,288,008		
Consumption vs. Previous Fiscal year [%]					97.4%		****

Private power generator [reference data]

Generator		Unit	Annual quantity	Remarks	Type
Output	Generated electricity a+b	kWh	2,190,000		Gas engine 750kVA Output 600kW
	a. Own use	kWh	1,290,000		
	b. Sold	kWh	900,000	Sold to Grid	
Input	Natural gas	Nm^3	1,000	Included in the above table	

Table 7- 4 Format 2: Equipment List

Operational status of energy consumption equipment, and installation & removal of the e

Name of equipment	Brief of eqipment	Operational status	Installation & removal
Air compressors	90kW x 8 units	365 days/year, 20 hours/day	
Chillers	43kW x 8 units	365 days/year, 20 hours/day	
Chilled water pumps	45 kW x 3 units	365 days/year, 20 hours/day	
Transformers	1,000kVA x 8, 2,000kVA x 3	365 days/year, 24 hours/day	
Generator	600 kW (Gas engine)	200 days/year, 10 hours/day	
Steam boiler	10t/h, 5t/h, 5t/h	200 days/year, 10 hours/day	

Table 7- 5 Format 3-1: Energy Intensity Calculation Sheet

Closely related unit to energy consumption

Production volume or closely related unit to energy consumption	FY 2011	Unit vs. previous fiscal year
Production volume	55,000 ton	110%

Energy Intensity and Electricity Intensity

Primary energy	FY 2011	Unit vs. previous fiscal year
$EI = \frac{\text{Annual energy consumption (MMBtu)}}{\text{Production volume or closely related unit to energy consumption}}$	58.23 MMBtu/ton	98.3%
Electricity	**FY 2011**	**Unit vs. previous fiscal year**
$EI = \frac{\text{Purchased \& generated annual electricity consumption (kWh)}}{\text{Production volume or closely related unit to energy consumption}}$	423.45 kWh/ton	98.2%

Table 7- 6 Format 3-2: Energy Intensity Historical Record

Status of change in Energy Intensity for past five years

	FY2007	FY2008	FY2009	FY2010	FY2011	5 years average EI change
Energy Intensity (MMBtu/ton)	60.88 (a)	60.32	59.44	59.23	58.23 (b)	
Intensity vs. previous fiscal year (%)		**-0.9%**	**-1.5%**	**-0.3%**	**-1.7%**	=1-(b/a)^1/4 **-1.1%**

Status of change in Electricity Intensity for past five years

	FY2007	FY2008	FY2009	FY2010	FY2011	5 years average EI change
Electricity Intensity (kWh/ton)	440.91 (a)	442.23	433.38	431.22	423.45 (b)	
Intensity vs. previous fiscal year (%)		**0.3%**	**-2.0%**	**-0.5%**	**-1.8%**	=1-(b/a)^1/4 **-1.0%**

Reasons (Energy/Electricity intensity target is not improved)

(A) Energy/Electricity intensity target for past five years is not achieved (1% improvement)
(B) Energy/Electricity intensity target is not achived from the previous year (1% improvement)

Table 7- 7 Format 4: EE&C Plan

Detals of the plan and expected effects

Target	Details of the plan	Implementation	Expected effects
Pumps	Installation of inverter control	FY 2012	Reduction of 30,000 kWh/year

(e) Evaluation Methods of Inappropriate Energy Conservation Activities and their Penalties

The item discusses the evaluation methods of improper energy conservation activities and the proper way to administer penalties in such cases. As a result of the discussion with the Sub-Committee, the following procedures and penalties were decided in the event that the consumer did not comply after receiving a warning. It was also proposed that the first penalty would be the disclosure of the organization's name and the name of the registered Energy Manager and the second penalty would result in a fine being charged.

(First Step)

Document Check by the Regulatory Body
- Check performance of EE&C activities from Periodical Report
- Check accuracy of Periodical Report
- Review results of energy audit conducted by Energy Auditor(s)

(Second Step)

Inspection by Inspector
- Confirm practice of EE&C activities by inspection
- Confirm accuracy of Periodical Report
- (In case problems are identified) Giving instructions to the site

(Third Step)

Re-Inspection by Inspector (1 year after the first inspection)
- Confirm that the situation has improved after the instructions
- (In case it is judged that performance has NOT improved) Administer the first penalty!

(Fourth Step)

Re2-Inspection by Inspector (1 year after the re-inspection)
- Confirm that the situation has improved after the first penalty
- (In case it is judged that performance has NOT improved) Administer the second penalty!

Figure 7- 5 Judgment Procedure for Improper Management Consumer

(3) Proposed Framework after the Discussions

From the above discussion results regarding design items of the scheme, 2 options, "Option 1: Management for only electricity" and "Option 2: Management for both electricity and fuel", were finally proposed as the framework for the Energy Management System. The schematic flow chart of options is shown below.

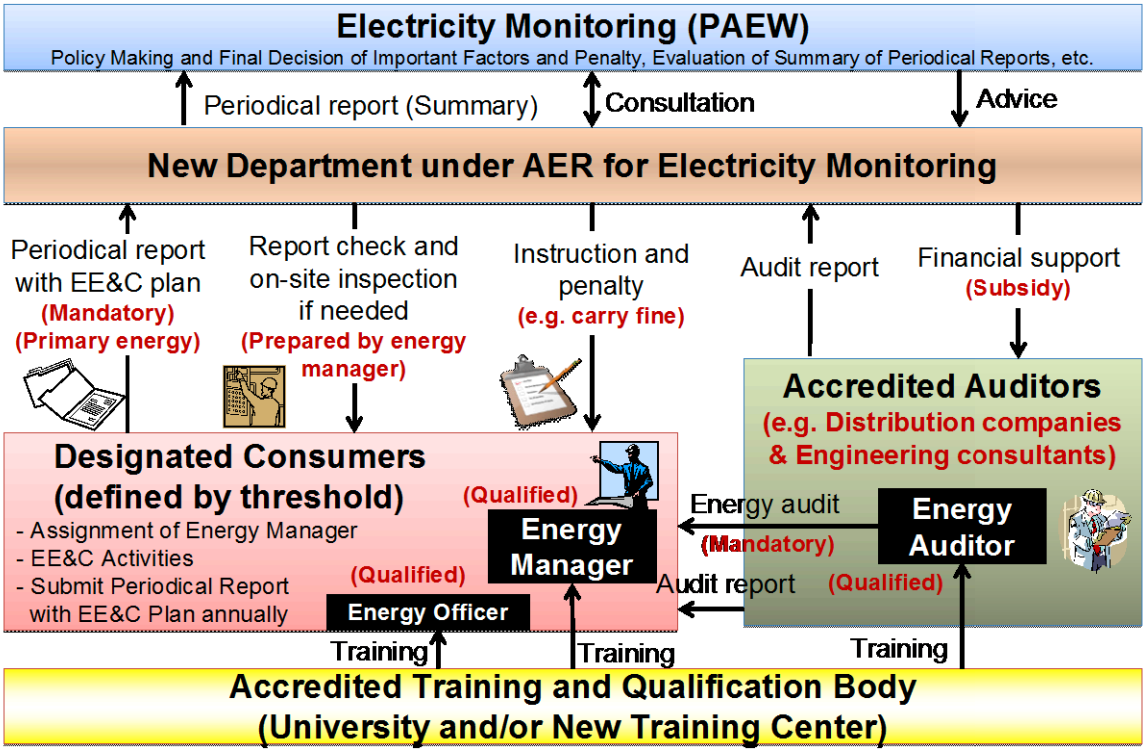


Figure 7- 6 Option 1: Schematic Flow Chart (in case of Management for Only Electricity)

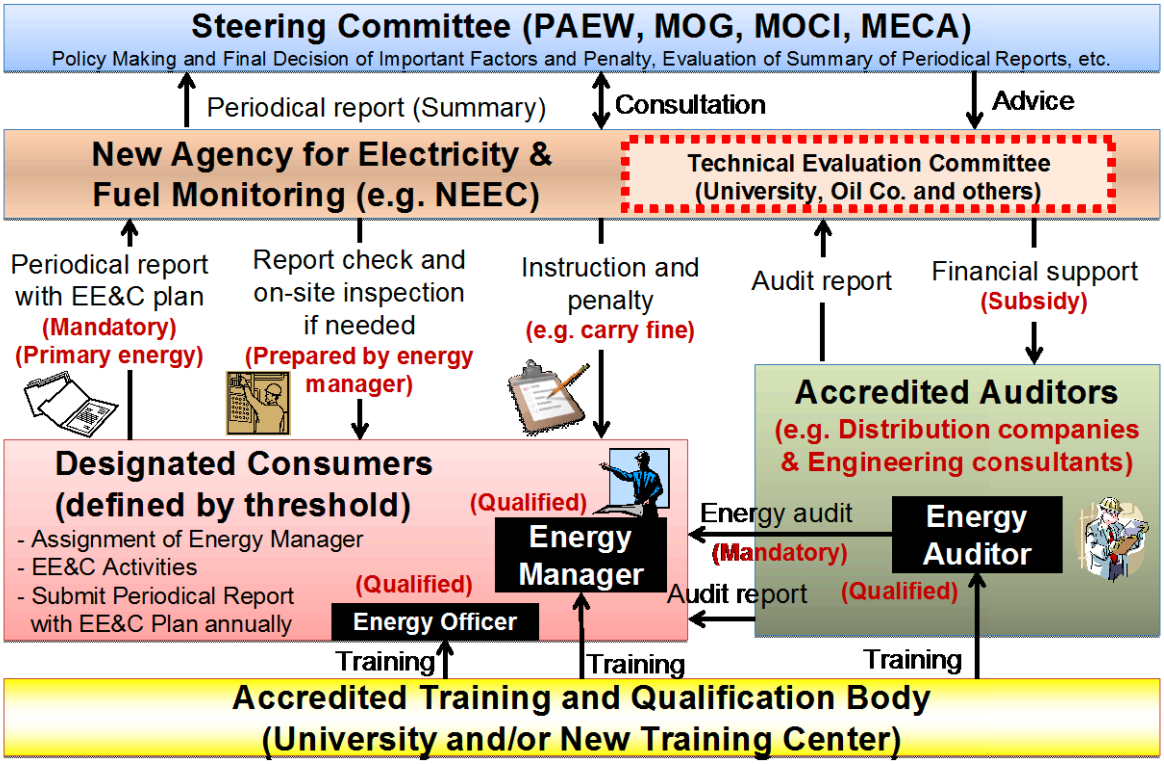


Figure 7- 7 Option 2: Schematic Flow Chart (in case of Management for Both Electricity and Fuel)

7.3 Minimum Energy Standards and Labeling System

7.3.1 Design Items for Scheme Framework

Similar to the framework design of the Energy Management System, the scheme design is discussed in 2 steps, a primary step for fundamental design items and a secondary step for supplementary design items.

With regard to the scheme for Minimum Energy Standards and Labeling System, it was confirmed that the following design items were discussed.

(Fundamental Design Items)

- Implementation Formation
- Target Appliance
- Contents to be Indicated in the Label

(Supplementary Design Items)

- Data and Information to be Submitted and Published
- Rules for Dealing with Dissatisfactory Appliances
- Procedure to Decide Important Factors

7.3.2 Discussion Results of Each Design Item

(1) Discussion of Fundamental Design Items

(a) Implementation Formation

The item discusses the implementation formation and roles of each player. As a result of the discussion with the Sub-Committee, it was finally proposed that the Ministry of Commerce and Industry (MOCI), which has been in charge of quality and safety tests for equipment, was the main executing agency for the scheme. The MOCI was proposed to be the regulatory body and conduct works for policy making, establishment of test standards, verification of test facilities, random tests, databases, etc.

Besides, the following points relating to the item were confirmed to be the final proposal.

- It is possible to accept the performance test results verified by the third party test laboratories authorized by MOCI, if it is assured that the test is properly conducted in accordance with test standards established by MOCI. The test data and other information for every new product must be submitted to MOCI.
- The test facilities in the third party's laboratories are verified and periodically corrected by MOCI.
- MOCI will have its own test facility, and at least an AC test facility. The purposes of holding the facility are to : (i) test by themselves for at random tests, (ii) verification and correction of the test facilities of manufacturers and importers.
- Dissemination agencies to cooperate for dissemination of the scheme are set up.
- Label sheets should be prepared by manufacturers or importers and retail shops

should attach the labels for displayed appliances.

(b) Target Appliance

The item discusses what appliances are targeted by the scheme. As a result of the discussion with the Sub-Committee, it was finally proposed that 5 products, "AC, Refrigerators, Freezers, Washing Machines, and Lamps", were targeted by the scheme. Given that the same scheme has been already adopted for these appliances by Saudi Arabia which has similar weather and customs to Oman (In Saudi Arabia, the AC, Refrigerators, Freezers and Washing Machines have been covered by the scheme and the Lamp is also planned to be included in the near future). Thus, it is expected that barriers against adopting the scheme in Oman are not so high for such products.

(c) Contents to be Indicated in the Label

The item discusses the contents to be indicated in the label. As a result of the discussion with the Sub-Committee, the following data and information were finally proposed in consideration of the experiences of Saudi Arabia and Japan.

- AC: COP and Annual Electricity Consumption
  (In Saudi Arabia, only COP is indicated as a performance data. However, in Oman, annual electricity consumption is also added because it is easy to understand performance of AC.)
- Refrigerator, Freezer, Washing Machine: Annual Electricity Consumption
- Lamp: Power Consumption, Illuminance, Efficiency (lm/W)
  (The contents refer to the Japanese label for lamp.)
- Comparative stars are introduced.
- Labels for ACs, Refrigerators and Freezers indicate the name of the refrigerant used in compressors.

(2) Discussion on Supplementary Design Items

(a) Data and Information to be Submitted and Published

The item discusses what data and information must be submitted to MOCI and how it is to be released to the public in published form. As a result of the discussion with the Sub-Committee, the following contents were finally proposed as an obligation to manufacturers and importers. This data and information will be compiled at MOCI's database which can be accessed by consumers and retail shops, and also released to the public via the internet, pamphlets, etc.

- Name of manufacturer
- Name of product
- Production year
- Name of type
- Input and out put energy and energy efficiency indicator
- Annual electricity consumption
- Comparative stars
- Name of refrigerant, etc.

(b) Rules for Dealing with Unsatisfactory Appliances

As a result of the discussion with the Sub-Committee, it was finally proposed that appliances which did NOT satisfy the minimum standards were basically forced off of the market when the manufacturers receive an instruction from MOCI and not improved even after the instruction.

(c) Procedure to Decide Important Factors

For Minimum Energy Standards and Labeling System, it is assumed that there is a large amount of stakeholders such as consumers, manufacturers/importers, retail shops, power utilities, MOCI/PAEW, etc. Thus, it is desirable to decide important factors for the scheme via a discussion among all the stakeholders. As a result of the discussion with the Sub-Committee, it was finally proposed that a representative committee which had the function to coordinate the interests of stakeholders should be established.

The committee, the "Standard Establishment Committee", will make a recommendation to MOCI on test standards, the minimum standard level, the comparative evaluation (comparative stars), instruction and penalties for the improper indication of data and information, etc. Academic experts, researchers, consumer representatives, manufacturers/importers, retail shops, distribution companies, MOCI/PAEW, etc. are recommended for the committee members.

(3) Proposed Framework following Discussion

Based on the above discussion results regarding the design items of the scheme, the framework for the Minimum Energy Standards and Labeling System was finally proposed. It was decided that MOCI would be the main executing agency and dissemination agencies would help with dissemination. The schematic flow chart of the options is shown below.

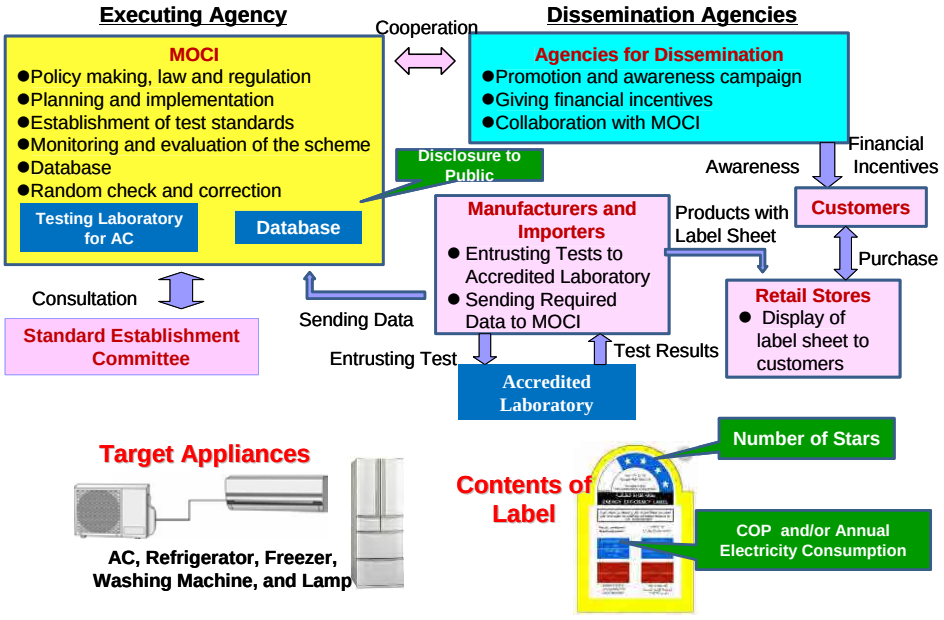


Figure 7- 8 Schematic Flow Chart for Minimum Standards and Labeling System

7.4 EE&C Building Regulation

As with other countries, Oman has a regulation that requires applicants to apply for a building permit to the government office in charge by submitting design documents etc. and they can start construction after receiving building permits. Currently, the standards for EE&C are not specified in this regulation. The topic of "EE&C Regulation for Buildings" to be discussed here is about how to integrate EE&C standards into the permit approval procedures.

There are building regulations implemented by each government office in charge. There is, however, a move to establish "Building Code" targeting whole Oman, revising existing regulations. The discussion results in the Study will be succeeded by a Sub-Committee for EE&C under the National Committee of Building Code (hereinafter referred to as "NCBC"), which is planned to be established as a permanent body.

7.4.1 Design Items for Scheme Framework

With regards to the scheme for EE&C regulation for buildings, it was confirmed that the following design items were discussed.

(Fundamental Design Items)

- Implementing Agency
- Targeted Buildings
- Targeted Timing
- Scope for the Standards to be Applied (building envelope and equipment)

(Supplementary Design Items)

- Necessity of Site Inspection and Penalty
- Testing of Building Materials and Testing Institutions

(Reference Items)

- Forms of Requirements (component prescriptive type, component performance type, overall performance type)

7.4.2 Discussion Results of Each Design Item

(1) Discussion of Fundamental Design Items

(a) Implementing Agency

Currently, building regulations are established and implemented by the institutions below. In the future, NCBC will be established and in charge of establishing and revising the building code.

The existing governmental agencies in charge which provide building permits are the candidates for the implementing agency. The following agencies are nominated.

- ✓ Muscat Municipality
- ✓ Sohar Municipality

- ✓ Dhofar Municipality
- ✓ Duqum Municipality
- ✓ Ministry of Regional Municipalities and Water Resources
- ✓ Public Authority for Industrial Estates (e.g. Rusail, Sohar Raisut ad Nizwa)

(b) Targeted Buildings

This is a discussion concerning the buildings targeted by this regulation. Based on the discussion with the Sub-Committee, the following table describes the final proposal.

As for the residential sector, the villas have its limitation mainly according to the floor size. The reason for this is that although there is no statistical data, the floor size of the average houses seems to be about 300 m^2 and it would be difficult for them to comply with EE&C standards at the start of regulation implementation. However, the exclusion of the average houses may lessen the effects of the regulation. Thus, villas of up to 2 stories and with a total floor area of 500 m^2 or less will be excluded in the initial stages of the regulation, but a target extension will be considered in the future. In the same manner, the limitation of the total floor area for flats was set at 1,000 m^2.

In addition, office buildings in the industrial sector are also targeted for EE&C standards, as they are regulated under the current building permit regulation.

Table 7- 8 Targeted Buildings for EE&C Standards

Sector	Targeted Buildings	
Residential Sector	Villas	All Villas of up to 2 stories (and with a penthouse) and with the total floor area less than 500 m^2 less are exempted.
	Flats	All Flats with the total floor area of 1,000 m^2 or less are exempted.
Commercial Sector	All	
Government Sector	All	
Industrial Sector	Only office buildings are targeted.	

(c) Targeted Timing

This is a discussion about which timing, “new construction”, “retrofitting”, “additional installation (including equipment)” should be targeted. Based on a discussion with the Sub-Committee, “new construction” should be targeted as a first step.

The reason for this is that 98 % of current building permits are given for “new construction”. A target extension will be considered in the future. In addition, the promotion of incentive programs, for example, adding thermal insulation to existing buildings also needs to be considered.

(d) Scope of the Standards to be Applied (Building envelopes and equipment)

This is a discussion about whether both building envelopes and equipment should be targeted, or only building envelopes should be targeted. Based on the discussion with the Sub-Committee, the final proposal is that both building envelopes and equipment should be

targeted.

The reason is that both thermal performance improvements of the building envelopes and the thermal efficiency improvements of the equipment are necessary for EE&C. On the other hand, at the beginning of the discussion, there was a concern whether or not existing staff in governmental agencies in charge could handle the situation if "equipment" was included. However, "both" were chosen on the condition that the measures for capacity building should be studied by the time the regulations are implemented.

(2) Discussion about the Supplementary Design Items

(a) Necessity of Site Inspection and Penalties

Engineering consultants and contractors are obliged to secure quality of construction in the existing regulation. It is the discussion here whether or not site inspections and penalties by the government agencies in charge are necessary.. The final proposal is that implementing agencies will randomly inspect 20 % of the sites.

The reason why random inspection was chosen is as follows; if all the sites will be inspected, which means site inspections will be given upon the request from the builders/building owners, it might happen that they prepare the sites only for inspection, for example, they might prepare only the limited portions in the condition of complying the regulation. The Sub-Committee reached a conclusion that random inspection can function by setting up the penalty high. In case of provision of public financial aids such as subsidy, inspections for all the sites are required.

As for the penalty, it will require a site inspection. Thus, a penalty may be levied when the site is inspected and also whenever else it is deemed necessary.

(b) Testing of Building Materials and the Testing Institution

One of the necessary conditions in order to check whether the designs permitted are followed is that material performances should be tested and the certification marks and/or testing results should be attached to the materials when purchased or installed. Such a scheme for material testing standards has already been established under MOCI law and some are already included in the standards list (refer to next table). It is necessary to add necessary items to this MOCI scheme regarding the thermal performance of building materials.

Table 7- 9 Examples in the Standard List of MOCI regarding Building Materials

Standard No.	Issue Year	Title
OS GSO 1122:2002	2002	Methods of test for rigid polyurethane foam boards for thermal insulation
OS GSO 1121:2002	2002	Rigid polyurethane foam boards for thermal insulation
OS GSO ISO 8301:2007	2007	Thermal insulation – Determination of steady – state thermal resistance and related properties – Heat flow meter apparatus

(Source: MOCI Website)

(3) Forms of Requirements (Reference)

There are three types for EE&C standards, as shown in the next table, with different level of difficulties, and they, historically, have developed from 1) to 3). At the beginning of the discussion, it was thought that choices of forms of requirements might affect the choices of implementing agencies. Thus, it was agreed to treat it as one of the discussion items. As the result of the discussion, it did not affect the choices of implementing agencies and it is difficult to decide at this moment and it was agreed to treat it as reference information. The following is the reference information regarding forms of requirements.

The following three types were raised as the forms of requirements. Japan, US, Saudi Arabia (which follows the US standards) provides all types of requirements.

Table 7- 10 Options of Forms of Requirements regarding EE&C Standards for Buildings

	Characteristics and Examples	Advantages	Disadvantages
1) Component Prescriptive Type	Indicators for each part are stipulated. - Glass U-factor - Ceiling R-value - Wall R-value, etc.	- It is easy to comply with.	- It disturbs choices of design and materials. - There is a limitation in applying this type, e.g. maximum glazing area.
2) Component Performance Type	- Indicators are overall U-factor, etc.	- It is not so difficult to comply with.	- It relatively disturbs choices of design and materials.
3) Overall Performance Type	- Energy consumption is simulated. - Simulated energy consumption is compared to the one of "Standard Simulation". - Simulation tools are necessary.	- It is most effective to describe the performance. - It allows designers freedom within the performance standards.	- It is usually rather difficult to calculate the performance indicators. (Experts are needed.)

7.4.3 Proposed Framework after the Discussions

Based on the discussion of the above design items, the final proposal for the EE&C regulation for buildings is as follows.

- The procedures for building permits will be implemented as follows under the Building Regulation/Code of the governmental agencies in charge.
  - ✓ Applicants apply for building permits.
  - ✓ Governmental agencies in charge check the documents including EE&C standards, and provide building permits when they comply with the law.
  - ✓ Site inspections are conducted randomly.
  - ✓ Penalties are levied, only when necessary.
- Securing the quality of construction will be implemented under the Building Regulation/Code as follows:
  - ✓ Regarding whether the appropriate building materials are installed, engineering consultants check the documents and the sites including their testing results
  - ✓ Contractors, in order to secure proper installation of building materials according to the design, check the documents including the testing results of building materials

and install them properly.

- The procedures of building materials will be implemented as follows under the MOCI material standards regulation.
  - ✓ Manufacturers/importers commission testing of their materials to testing institutions or test them by themselves.
  - ✓ Testing institutions provide testing results to manufacturers/importers.
  - ✓ Manufacturers/importers send the testing results and get approvals from MOCI.
  - ✓ Manufacturers/importers sell materials with testing results.

The overall framework is summarized in the following scheme figure.

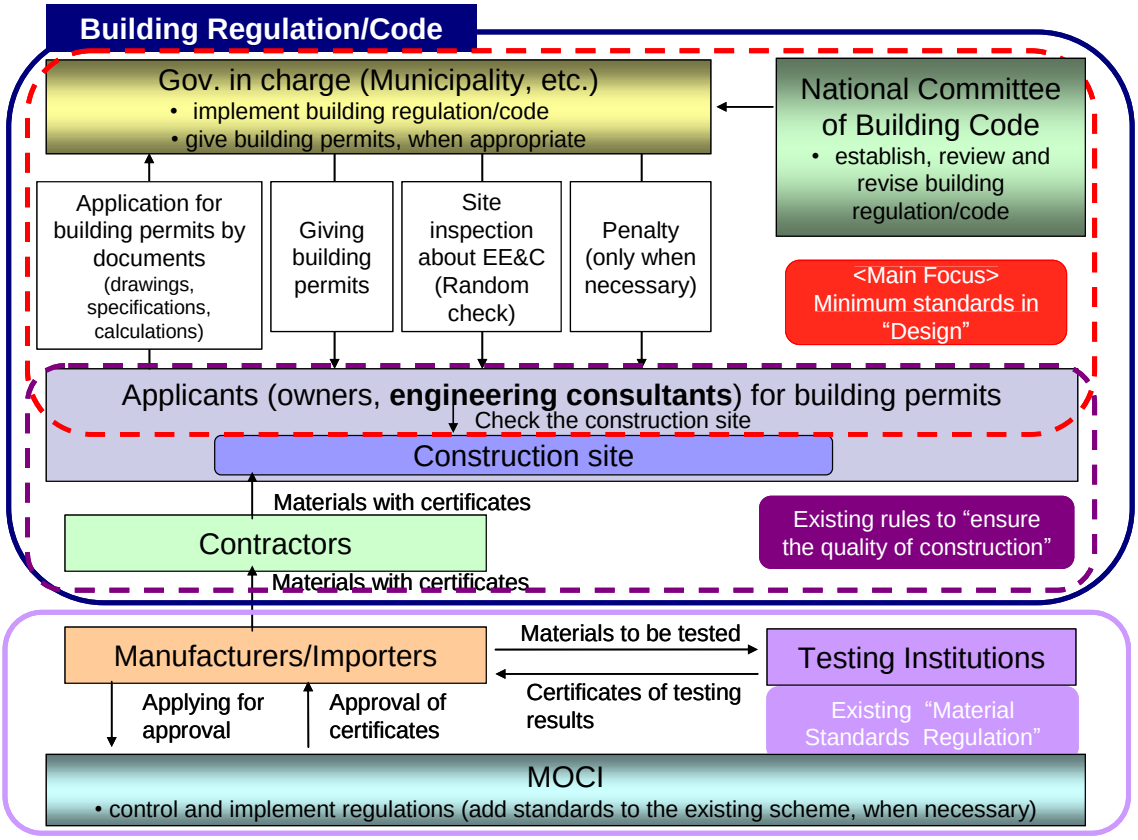


Figure 7- 9 Overall Framework related to EE&C Standards for Buildings

7.5 DSM Tariff System

7.5.1 Discussions on Implementing the DSM Tariff System

Regarding the tariff incentives (DSM Tariff System) to serve for peak load reduction in Oman, the JICA Study Team initially planned to propose the implementation of the time-of-use (TOU) tariff as an appropriate measure. However, it turned out through a series of discussions with the stakeholders in Oman that, as explained in 5.7.3, there was a discussion

on the Cost Reflective Tariff (CRT), which is similar to the TOU tariff proposed by the Study Team, but that its implementation ended up being postponed.

There was a comment from some members of the Sub-Committee to discuss the DSM tariff in this Study so that even if it's offered as an optional tariff besides the current "Standard Tariff", this means a revision to the existing tariff system thus the approval of the Council of Ministers is required.

From the perspective of making a highly feasible proposal on the DSM tariff system in consideration of the future timeline for implementation, the following alternative idea was suggested at the Sub-Committee meetings.

- To leave the implementation of the TOU tariff as a future task; and
- To prioritize instead the implementation of the Demand Adjustment Contract, which was introduced by the Study Team as another type of DSM tariff incentive, as a transitional measure until the implementation of the TOU tariff (i.e. CRT).

To serve to facilitate more in-depth discussion for implementation in accordance with this suggestion, the JICA Study Team organized the main points to be considered in implementing the TOU tariff and the Demand Adjustment Contract respectively as follows. They were discussed at the Subcommittee meetings and agreed by the local stakeholders.

7.5.2 Overview and Pros & Cons of the TOU Tariff and Demand Adjustment Contract

The TOU tariff sets different unit rates among the seasons and time zones in response to expectations that the customers will voluntarily shift their load from peak hours to off-peak hours. On the other hand, the Demand Adjustment Contract aims at mitigating the tight balance between power supply and demand by allowing a power utility to request customers to shift a part of their operation during peak hours to off-peak hours and to pay the rebates for the actual performance.

There are various types of Demand Adjustment Contracts, and in consideration of the current status of the annual load pattern and the supply-demand balance in Oman, this Study considers the implementation of the "Contract of Adjusting the Summer Time Operations", in which the customers, upon prior agreement with the power utility, change their operational pattern during the summer time so that they suspend a part of their operations during the daytime peak hours (from 13^{h} to 17^{h}) and shift this to off-peak hours (17^{h} to 20^{h}). This is considered to be an appropriate option.

Regardless of the argument concerning the difficulty to implement the TOU tariff and the Demand Adjustment Contract, it also needs to be noted that the objectives and targets of these two systems are not necessarily identical, thus the difference between them needs to be taken into account when discussing their implementation. The image of the incentives provided by the TOU tariff and the Demand Adjustment Contract respectively and their pros and cons are summarized in the following figures and table.

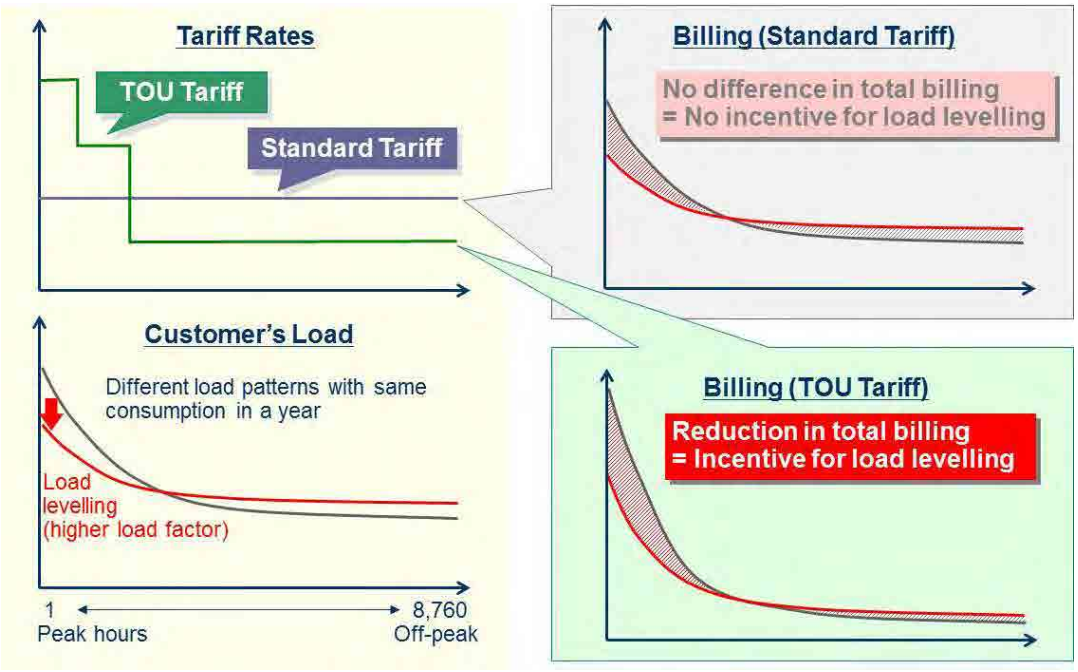


Figure 7- 10 DSM Incentive with the TOU Tariff (Image)

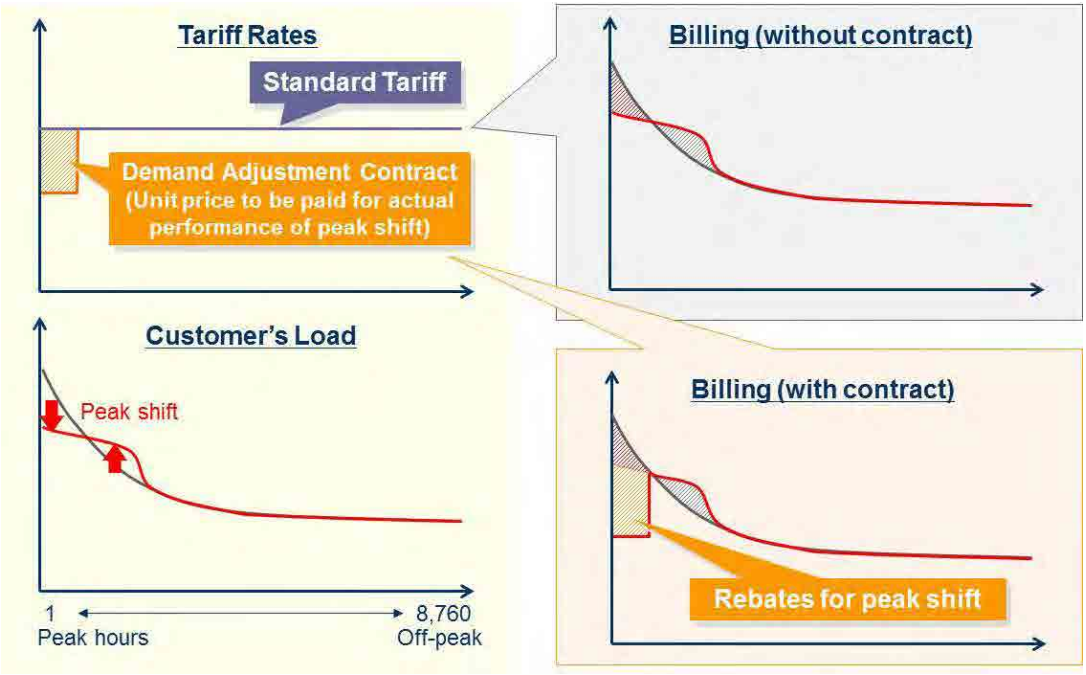


Figure 7- 11 DSM Incentive with the Demand Adjustment Contract (Image)

Table 7- 11 Overview and Pros & Cons of TOU Tariff and Demand Adjustment Contract

	TOU Tariff	Demand Adjustment Contract
Overview of the System	• Customers' voluntary peak shift is expected by setting the unit rates in summer peak hours high and the unit rates in off-peak hours and other seasons low. • Ready-made contract is provided for all eligible customers who like to choose TOU (when TOU tariff is provided as optional).	• Customers reduce their load to follow the request from the power utility when the supply-demand balance is tight. Rebates are paid depending on the actual performance. • Power utility sounds out the selected large customer's willingness to accept the contract and then the negotiation is made individually.
Pros	• Ready-made pricing → Applicable to all eligible customers without individual customization → No discrimination among eligible customers	• Direct effectiveness on the peak cut/shift can be expected (especially when imminent peak reduction is needed) • Clear relation between actual efforts of peak cut/shift and rebates paid
Cons	• Difficulty in predicting the direct effectiveness of the peak cut/shift (uncertainty for imminent peak reduction) • Some customers may benefit without further efforts of load leveling	• Individual customization for each customer is needed → Eligibility is confined to a small number of large customers → Fairness among customers may not be achieved

7.5.3 Issues to be Discussed in Designing the TOU Tariff and Demand Adjustment Contract

This section specifies the issues that need to be discussed in designing the TOU tariff and the Demand Adjustment Contract respectively, which were presented by the JICA Study Team.

(1) TOU Tariff

(a) Process of Approval and Implementation Framework

AER, the regulatory body, assumes responsibility for formulating the TOU tariff rates. Based on the data on the costs of supply, the power demand, and the power system load collected by OPWP (power generation), OETC (power transmission), and DisCos etc. the AER formulates a draft of the TOU tariff, and then, upon coordination with PAEW, the policymaker, proposes this draft to the Council of Ministers. In this process, public consultation on the TOU tariff is also made. After gaining the approval of the Council of Ministers, the DisCos start entering into contracts of the TOU tariff with the eligible customers.

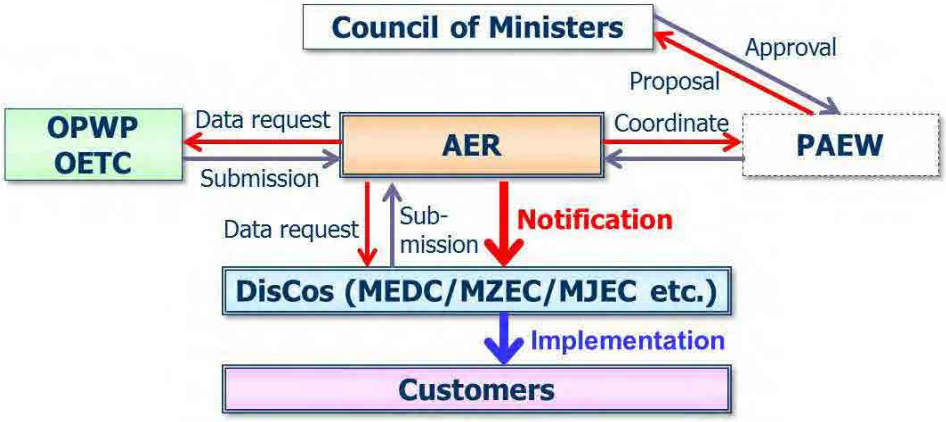


Figure 7- 12 Process of Approval and Implementation Framework (TOU Tariff)

(b) Targeted Area

The JICA Study Team suggested that the implementation of the TOU tariff can be confined to the MIS area (MEDC, MZEC, and MJEC). As discussed in 5.7.4, the expected peak shift effect of the TOU tariff may be very small in DPC's supply area considering the characteristics of the load curve in this area, and the number of eligible customers itself is very limited in RAECO's supply area.

However, there was a comment from a member of the Sub-Committee that in principle the same electricity tariff must be applied nationwide, thus the TOU tariff should cover the whole Oman.

(c) Targeted Sectors

In principle, the TOU tariff should target large customers in all sectors other than the residential sector. However, the eligible sectors may be confined to "industrial and commercial sectors only", or "industrial, commercial, and government sectors only", considering that the current tariff system offers low unit rates for agriculture & fisheries etc. According to the AER, the planned CRT will cover the "industrial, commercial, and government customers" and considering that there are very few large customers in other tariff categories who can be eligible, it would be appropriate to follow this definition.

Given that there's no significant difference in the consumption behaviour between the commercial and government sectors, it is rational to apply the same TOU tariff rates for both sectors. In the meanwhile, it also needs to be noted that the currently different tariff rates are set for these sectors, thus if the current tariff rates are maintained as the "Standard Tariff", the balance of the billing amount between the TOU tariff and the "Standard Tariff" is also different. However, the government tariff become higher than the commercial tariff when the monthly consumption exceeds 12,500 kWh, and hence it is more convenient for the large government customers that the same TOU rates as the commercial customers are applied than that the TOU rates are set to balance with the "Standard Tariff" for government customers.

Regarding the definition of eligible "large customers", "customers to whom electricity is

supplied at 11kV or higher (maximum demand: 60 kW or more)" may be one appropriate option. For smooth implementation, starting with a limited number of very large customers (e.g. maximum demand: 500 kW or more) and gradually expanding it to smaller customers can be considered.

(d) Rate Setting

From the aspect of economic rationality, the unit rates should be set by appropriately reflecting the costs of supply in each time zone. The TOU tariff model in MIS area, which is presented in 5.7.4, is also designed to follow this idea. When this tariff model is applied to a customer with a typical load pattern of the sector, the expected benefit of reduced billing is "an annual billing reduction by a little less than 2 % if the customer shifts 10% of the peak load to off-peak hours" for both industrial and commercial customers.

In the meanwhile, the customer will gain more benefit of reduced billing becomes larger by setting a larger margin of unit rates between peak hours and off-peak hours. Therefore, it is possible to consider adjusting the rates to meet the target of peak-shift reduction though the appropriate reflection of the cost of supply must be the basic principle.

(e) Methodologies of Cost Allocation

It is appropriate that the power generation costs are recovered by the retail tariff in relation to the BST's time-differentiated pricing. However, the time-zoning of the BST (May-July: 4 time-zones, August-September: 4, January-March: 1, April: 1, October: 1, November-December: 1) might be too complicated for the customers to respond properly to the rate of each time-zone, and this seasonal-zoning is not consistent with that of the existing industrial tariff (summer: May-August and other seasons). Therefore it's worth considering that the time-zoning of the TOU tariff be simplified rather than be linked strictly to the BST.

The transmission costs should also be allocated depending on the load of each time zone, considering the nature of the transmission costs that consist of mainly the facility-related costs and the billing of the Transmission Use of the System Charge that is imposed on DisCos in proportion to their annual maximum load.

Regarding the distribution costs, it is recommended that the facility-related costs be allocated depending on the load level of each time-zone. And as also pointed out by the KEMA report (see 5.7.3), it is more economically rational to allocate the costs of supply in consideration of the difference of the costs of supply depending on the voltage level. However, it needs to be noted that sufficient data for estimating the breakdown of the distribution costs by the voltage level are not ready, and that the attention needs to be paid to the consistency between the TOU tariff and the "Standard Tariff" (if the TOU is set as an optional menu besides the "Standard Tariff") because the latter does not account for the receiving voltage differences.

(f) Frequency of Revising the Tariff Rates

The BST, which provides the basis for calculating the cost of supply, is revised every year, and if the TOU tariff is designed to reflect this as strictly as possible, the TOU tariff rates also need to be revised accordingly.

However, the BST's unit rates fluctuate considerably every year, e.g. the unit rate during the daytime peak hours from May to July increased from 50 RO/MWh in 2011 to 55 RO/MWh in 2012 while the unit rate during the nighttime peak hours dropped from 20 RO/MWh to 14 RO/MWh, and changing the TOU tariff rates in proportion to that may discourage the customers' willingness to adopt the TOU tariff. In consideration of the customers' convenience, it might be better to maintain the same rates for a certain period (at least for several years).

(g) Contract Period

The benefit of the TOU tariff for customers should be evaluated by comparing its annual billing with that of the "Standard Tariff". Therefore, the unit of the contract period should be one year and the contract will be revised automatically unless the customer requests that it be terminated.

(2) Demand Adjustment Contract

(a) Process of Approval and Implementation Framework

The AER commented on the Demand Adjustment Contract that, unlike the case of the TOU tariff, its implementation does not require the approval of the Council of Ministers, i.e. it is feasible within the discretion of AER and other stakeholders of this Study.

There are two possible cases of implementing the Demand Adjustment Contract. The first is that the AER decides on its specifications and all the DisCos implement the same scheme universally (see the dotted green circle in the left side of the below chart). The second is that each DisCo sets the specifications on its own and executes them upon AER approval.

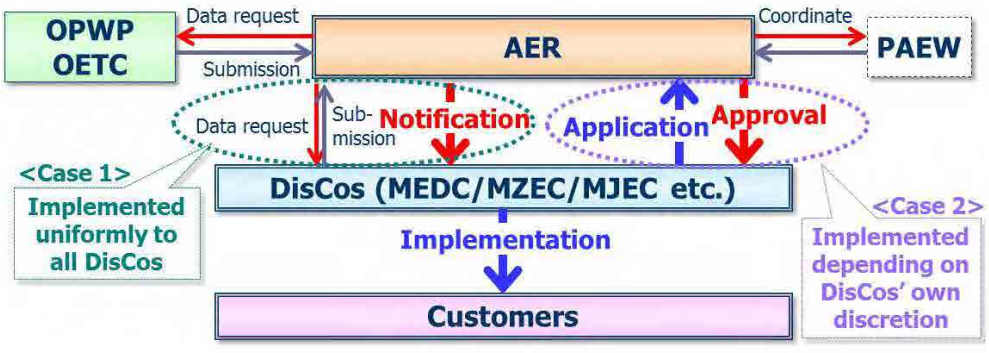


Figure 7- 13 Process of Approval and Implementation Framework (Demand Adjustment Contract)

(b) Targeted Area

In the first case, the Demand Adjust Contract should be applied universally nationwide, whereas in the second case it depends on each DisCo.

(c) Targeted Sectors

In general, the customers in the industrial sector have more flexibility to shift their operations than those in commercial and government sectors, thus large industrial customers should be the main target. However, there was a comment from the Subcommittee members that commercial customers should not be excluded from scratch and it is possible to also prepare this contract for them though much effect may not be expected.

As is the case of the TOU tariff, the demand size of the eligible "large customers" also needs to be defined.

(d) Unit Rate Setting and Cost Allocation

In the first case, the unit rate of the rebates to be paid for the customer's peak shift must be universal nationwide, and in the second case, each DisCo is able to set the rates at its own discretion. In the second case, the unit rates may not need to strictly reflect the costs of supply in each time zone but may be flexible depending on individual negotiation with customers.

In the first case, there's also a point to discuss whether the differentiated cost allocation among time zones should only consider the power generation costs (BST) or the power transmission costs should also be allocated to comply with the load in each time zone, like the case of the TOU tariff.

(e) Contract Period and Rate Revision Frequency

The contract period shall be one year and the conclusion of the contract between DisCos and the customers should be made before the summer high-load season starts. The unit rates can be revised every year because the Demand Adjustment Contract shall be executed in consideration of the year's power supply-demand balance.

(f) Others

Despite the stipulation of the Demand Adjustment Contract, some customers may not comply with DisCo's request to control the peak load. Whether or not penalty fines should be imposed on these non-complying customers will also be a point of discussion..

On the other hand, there may also be cases where the power supply-demand balance of the year becomes significantly eased than initially expected and the DisCos may inform the customers that there's no need to reduce the peak load as previously agreed upon. In this case DisCos may not need to pay the same incentive such as when the customers reduce their peak load to follow the DisCo's request, but need to pay a smaller incentive for the customers' peak shift readiness.

7.6 Smart Meter

Distribution companies and RAECO have already been implementing the pilot project of smart meters for the purpose of distribution loss reduction, fare billing. AER have already published the meter body specifications (OES-22D, E ,F), however, each company conducts the pilot project on their own terms, and also the specification of the system (e.g. related devices, servers, functions etc.) is still insufficient.

This section mentions the discussion results, which are on the unified functions and the effects.

7.6.1 Study Items to Introduce the Smart Meter System

The Sub-Committee 4 agreed to discuss the following study items concerning the introduction of smart meters in Oman.

- Role of each organization and framework to introduce smart meters
- Required functions of smart meters

7.6.2 Discussion Result of Each Item

(1) Role of each organization and framework to introduce smart meters

Sub-Committee 4 discussed the role of each organization and the framework to introduce smart meters to Oman. As a result of the discussion, Sub-Committee 4 decided to propose the following roles and framework for the final proposal.

- Distribution companies (including RAECO, DPC) are the main implementation bodies to install smart meters
- PAEW is in charge of policy making, and studies the function
- AER publishes and revises OES for the sake of the standardization of smart meters.
- EHC promotes sharing the study results among the distribution companies.

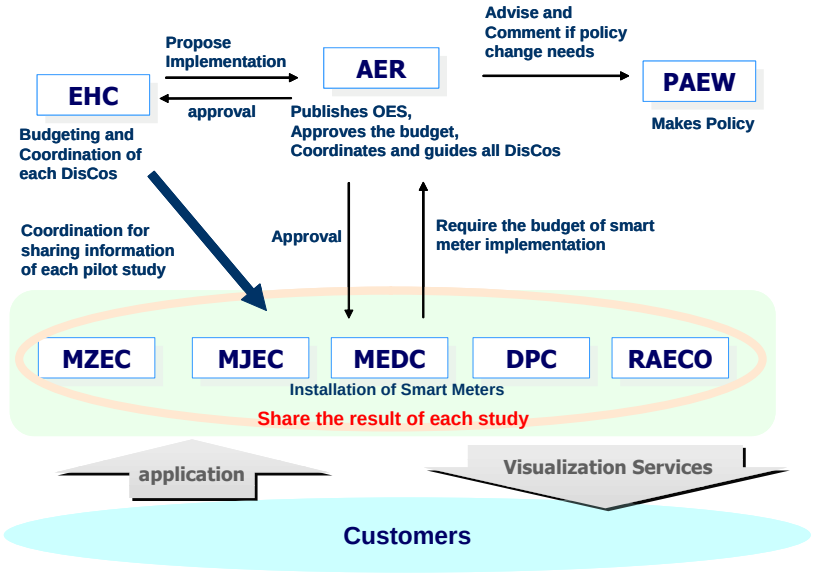


Figure 7- 14 Role of Each Organization and Framework to Introduce Smart Meter

(2) Required Functions of Smart Meters

Sub-Committee 4 discussed the necessary functions of smart meters. As a result of the discussion, Sub-Committee 4 decided to propose the following functions for the final proposal.

- Mandatory Functions are “Automatic Meter Reading”, “Tampering Detection”, “Remote Switching”, and “Visualization of Electricity Consumption (Web site)”. Smart meters should have the function for those systems. Also, the related equipment (e.g. MDMS, Electricity Consumption Information Providing Server etc.) should be installed.
- Regarding “Monitoring the status of the distribution line”, ” Detection of Outage”, “Prepaid”, “Storage of hourly consumption record”, the bodies of new meters has the functions for those systems. Additional facilities (servers etc.) for those systems will be installed and operated if necessary.
- Regarding the “Visualization system (in-home display)”, “Control of in-home appliance for DSM”, and “Network with in-home appliance (HAN)”, those functions are not needed at present. In addition, the bodies of new meters do not need to have the functions for those systems.

Table 7- 12 Necessary Functions of Smart Meter

	Function	Benefit	Implementation
For Operation Efficiency	Automatic Meter Reading	Reduced meter reading cost Reduced non-technical losses Fair billing	Mandatory
	Tampering Detection	Reduced non-technical losses	Mandatory
	Monitoring the status of the distribution line	Improved Efficiency of Facilities	If necessary
	Detection of Outage	Outage Management	If necessary
	Remote Switching	Shut off non-payment customers remotely	Mandatory
	Prepaid	Improved convenience for customers	If necessary
	Storage of hourly consumption record	TOU tariff	If necessary
For DSM	Visualization system (Web site)	Visualization of Consumption	Mandatory
	Visualization system (in-home display)	Visualization of Consumption	Future Function
	Control of in-home appliance	Direct Control for Demand Side Management	Future Function
HAN	Network with in-home appliance (HAN)	Provide Advanced Services	Future Function

7.7 EE&C Dissemination Program

7.7.1 Methodology for Discussion on an Effective EE&C Dissemination Program

(1) Methodology

Regarding the EE&C Dissemination Program, more effective programs are proposed after identifying the issues caused by existing programs or issues which are to be solved by the new programs. For instance, the JICA Study Team and members of the Sub-Committee 6 started to brainstorm utilizing the "Project Cycle Management" (PCM) tool. During the brainstorming with the PCM tool, the result of the current situation analysis of the Study and good practices in Oman, MECA, Japan and Saudi Arabia were introduced to the Sub-Committee members.

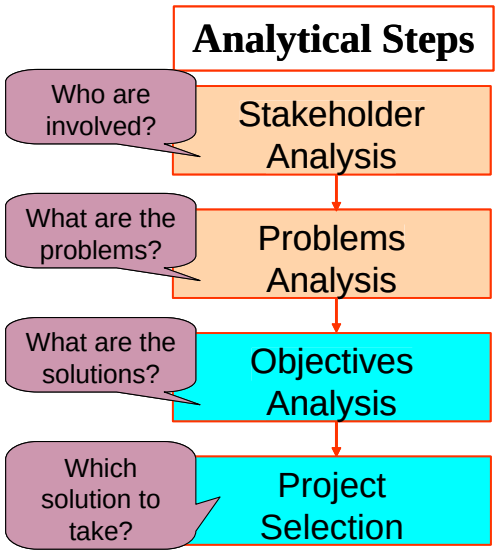


Figure 7- 15 Discussion Flow of EE&C Dissemination Program

(2) Target Sectors of the EE&C Dissemination Program

The EE&C Dissemination Program's objective is to raise public awareness. Therefore, the JICA Study Team has made a commitment with the Sub-Committee members to focus on the programs targeting the residential sector in consideration of the nationwide prevalence of EE&C awareness. There is another reason that the residential sector is an important target. Over half of the power consumption in Oman is consumed in the residential sector, and in the future, consumption is supposed to increase in step with the growing population.

7.7.2 Results of Discussion for an Effective EE&C Dissemination Program

(1) Setting up of the Core Problem by the PCM Tool

An analysis was conducted focusing on the Core Problem of "Why is the power consumption of one residence very large in Oman?"

(2) Result of the Problem Analysis via the PCM Tool

As a result of the Problem Analysis in the Sub-Committee, the following issues were identified.

Problem Analysis

- ✓ **No/Low awareness of EE&C**
  - ■ Rich people flaunt their wealth by not saving power.
  - ■ People are unfamiliar with the tariff calculation system.
  - ■ Children do not pay attention to the tariff.
  - ■ Tariff is too cheap to necessitate consideration.
- ✓ **Lack of Familiarity with EE&C**
  - ■ People unfamiliar with the concept of EE&C.
  - ■ People unfamiliar with the implementation of EE&C.
- ✓ **Use of electricity appliances is not appropriate for EE&C.**
  - ■ People have a habit of keeping too much food/drink in their refrigerators, so the size of the refrigerator is very large or the number of refrigerators is more than necessary.
  - ■ People do not adjust their ACs even if they feel cool/hot.
  - ■ Housewives do not have sufficient EE&C knowledge.
  - ■ In general, there are no ventilation fans, so windows and doors are kept open even when ACs are running.
  - ■ ACs appropriate for large rooms are not sold in Oman.
  - ■ Maintenance of appliances is not appropriately conducted.
  - ■ There is no habit of switching off water heaters while sleeping at night.
- ✓ **Efficiency of existing residences is inappropriate for EE&C.**
  - ■ In general, there are too many rooms because several families live together and separate family members return home on weekends.
  - ■ Lightings with an automatic lights-out function are not distributed in Oman. Efficient lighting is presently non-existent.
  - ■ Few architects and builders have the necessary knowledge and skills, so there is no insulation in the existing residences.

(3) Results of the Objective Analysis with the PCM Tool

As a result of the Objective Analysis at the Sub-Committee, the following solutions (programs) were selected as discussion items.

(a) Recommendations for on Existing EE&C Dissemination Programs

- EE&C awareness programs (Trainers are distribution companies, women, government officials and Imams)

(b) Proposal of New EE&C Dissemination Programs

- Educational programs for trainers (teachers)
- Media campaigns (especially TVs, cell phones and games)
- EE&C events (especially, large shopping malls in large cities)
- Energy consumption monitoring system (Provide visual breakdowns)
- EE&C educational museum dealing with Edu-Entertainment on EE&C
- Evaluation to optimize dissemination programs (EE&C awareness survey)
- AC's maintenance programs
- Establishment of Energy Efficiency Conservation Center dealing with all dissemination programs

7.7.3 Outline of Each Program

(1) Categorization of Proposed Programs

Proposed dissemination programs are shown in the following table based on the result of an Objective Analysis.

In addition, the programs are categorized into three types according to the organizational structure such as "Type A: National Program" where the program works more efficiently if it is implemented nationwide, "Type B: National & Local Collaboration Program" where the program works more efficiently if it is implemented in collaboration with the central government and local leaders, and "Type C: Local Program" where the program works more efficiently if it is implemented in a local area.

In order to promote the EE&C dissemination program, one of the proposals is the newly established National EE&C Center called "NEEC" (The organizational structure of NEEC is described in Chapter 8). It is assumed that power utilities should be local EE&C promoting leaders.

The role allocation of each program is shown in the following table.

Table 7- 13 Categorization of Proposed Dissemination Programs

Types of Programs	Title of Programs	NEEC		Local EE&C Promoting Leaders	
		Budget/ Plan	Implementation	Budget/ Plan	Implementation
Type A: National Program	Awareness and Monitoring Survey for Evaluation of EE&C Dissemination Program	○	○		
	EE&C Award Scheme	○	○		
	Subsidy Scheme	○	○		
Type B: National/ Local Collaboration Program	Mobile EE&C Show Room	○			○
	National Education Curriculum Development, Training of Teachers	○	○ (Textbooks)		○ (Training)
	General Information on Mandatory Programs	○	○		○
	National EE&C Campaign	○ (National)	○ (National)		○ (Local)
	Study Tour to Power Facilities	○	○		○
Type C: Local Program	Customer Model Project			○	○

(2) Proposals of the New EE&C Dissemination Program

The outline and the organizational structure of each program are described.

(a) Type A: National Program

(i) Awareness and Monitoring Survey for the Evaluation of the EE&C Dissemination Program

The following table shows the outline of the proposal for the EE&C Awareness and Monitoring Survey.

Table 7- 14 Outline of EE&C Awareness and Monitoring Survey

Items	Contents
Objective	Awareness and monitoring survey on EE&C is conducted every year to evaluate the effectiveness of the dissemination programs and to monitor the change in awareness. The result of the awareness and monitoring survey is utilized to improve the dissemination program for the next year.
Implementation Agency	National EE&C Center (NEEC)
Outline	1) NEEC plans and implements the awareness and monitoring survey. 2) The result of the survey is the input in the database of NEEC. Based on the data, NEEC analyzes the change in awareness. 3) The result of the survey and NEEC' s analysis is shared among the stakeholders of the EE&C dissemination program such as the government, power utilities and private companies.

The EE&C Awareness and Monitoring Survey is recommended to yearly conducted. The main contents of the questionnaires are lifestyle, behavior for EE&C, awareness on EE&C. To obtain more effective answers of the questionnaire, it is expected that a continuous survey with the well experienced local consultant is implemented. It is important to give incentives for the respondents in order to increase the number of respondents and to grasp the current level and change in awareness of the various generations. The following figure shows the implementation structure.

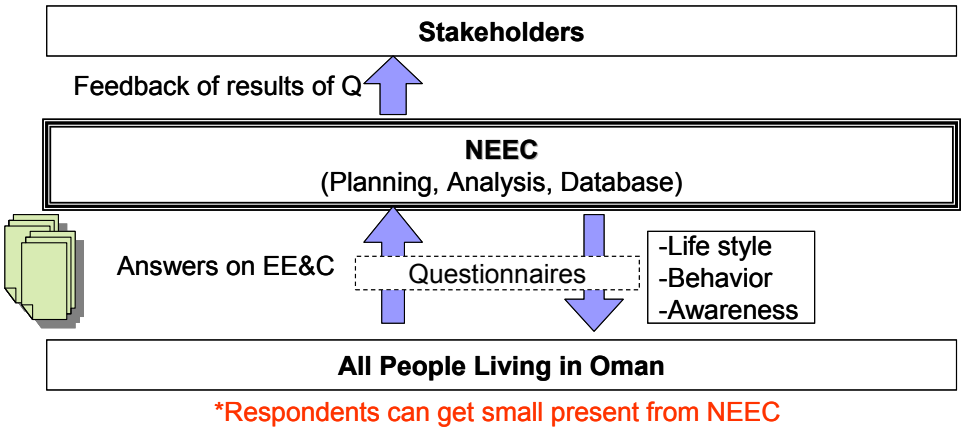


Figure 7- 16 Implementation Structure for EE&C Awareness and Monitoring Survey

Implementation Structure for EE&C Awareness and Monitoring Survey

(ii) EE&C Award Scheme

The following table shows the outline of the proposal for the EE&C Award Scheme.

Table 7- 15 Outline of EE&C Award Scheme

Items	Contents
Objective	In order to promote EE&C programs in Industrial, Commercial and School sectors, NEEC evaluates and awards good practices.
Implementation Agency	National EE&C Center(NEEC)
Outline	1) NEEC distributes the application forms to candidates. 2) Applicants (factories, buildings and schools) submit the application forms of the award to NEEC. 3) NEEC accumulates data from the application forms. 4) The best practices in each sector are selected in the evaluation committee for the EE&C Award. 5) The prize winners are awarded from NEEC.

The EE&C Award Scheme is implemented once a year. In order to promote EE&C programs in factories, buildings and schools, the award scheme targets industrial, commercial and school sectors. The evaluation committee is established as a third party council which is composed of EE&C experts. The implementation structure is described in the following figure.

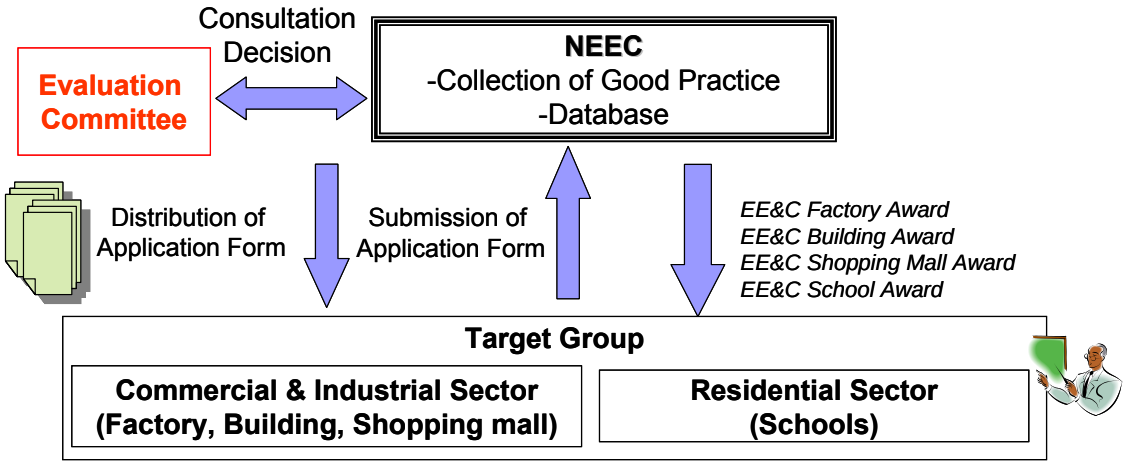


Figure 7- 17 Implementation Structure for EE&C Award Scheme

(iii) Subsidy Scheme

The following table shows the outline of the proposal for the Subsidy Scheme.

Table 7- 16 Outline of Subsidy Scheme

Items	Contents
Objective	In order to accelerate EE&C in the Industrial, Commercial and Residential sectors, the subsidy scheme promotes the purchase of highly-efficient appliances/equipment in the Industrial, Commercial and Residential sectors and the energy audit in the Industrial and Commercial sectors.
Implementation Agency	National EE&C Center (NEEC)
Outline	1) NEEC distributes the application forms for the subsidy. 2) The applicants submit the application forms and the other necessary documents to NEEC. 3) NEEC screens the applications and provides a subsidy.

The budget for the Subsidy Scheme is supplied from the Ministry of Finance as the capital of a part of the national benefit brought about by EE&C measures. The NEEC procures, manages and supplies the budget. As a general rule, the applicants for the subsidy need to send the application forms and the official receipt or other evidence to the NEEC due to proving the purchase of appliances/equipment.

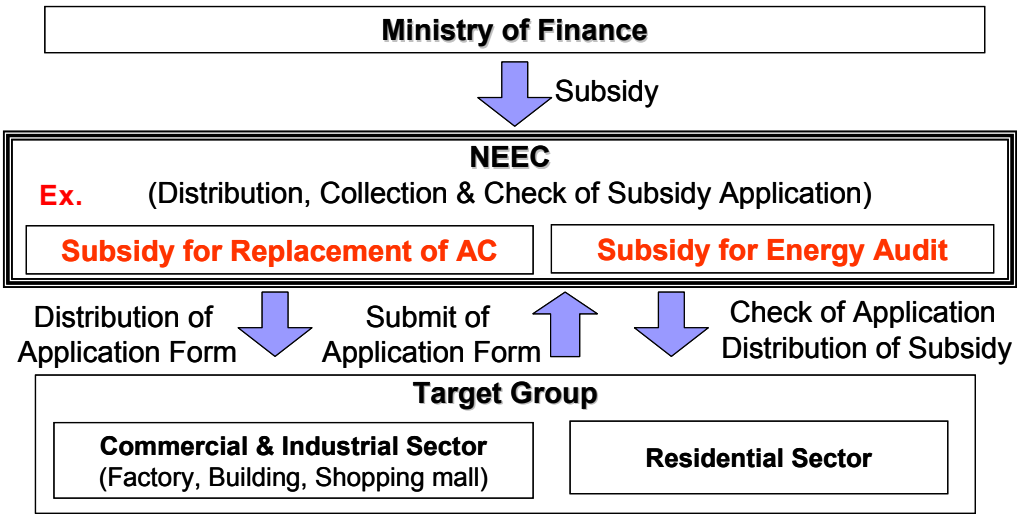


Figure 7- 18 Implementation Structure for Subsidy Scheme

(b) Type B: National and Local Collaboration Program

(i) Mobile EE&C Show Room

The following table shows an outline of the proposal for the Mobile EE&C Show Room.

Table 7- 17 Outline of Mobile EE&C Show Room

Items	Contents
Objective	As for the dissemination of EE&C education throughout Oman, the mobile EE&C show rooms are established and various EE&C appliances/equipment are shown at school.
Implementation Agency	National EE&C Center (NEEC) (budget and planning), Power utilities(implementation)
Outline	1) NEEC plans and establishes mobile EE&C show rooms with highly-efficient appliances/equipment. 2) The local EE&C promoting leaders (power utilities) implement EE&C education programs utilizing the show room at school. 3) The students learn EE&C from the mobile EE&C show room.

NEEC takes charge of the budgetary allocation and management of the appliances/equipment, while the power utilities such as distribution companies implement the arrangement of the details of the educational programs with the schools. The show room is expected to install interactive facilities as "Kid Zania" and an exhibition space for EE&C appliances/equipment. The following figure describes the implementation structure.

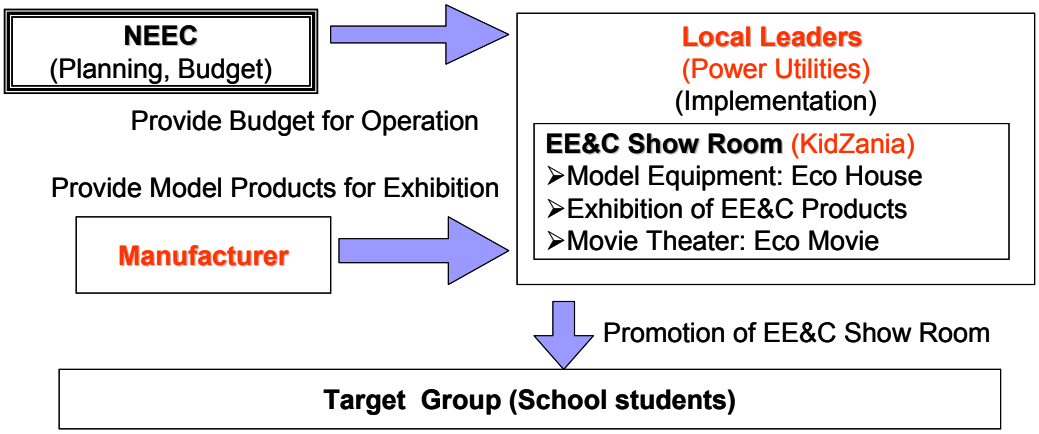


Figure 7- 19 Implementation Structure for Mobile EE&C Show Room

(ii) National Education Curriculum Development and Training of Teachers

The following table shows the outline of the proposal for the National Education Curriculum Development and Training of Teachers.

Table 7- 18 Outline of National Education Curriculum Development and Training of Teachers

Items	Contents
Objective	EE&C education needs for students due to disseminating the concept of EE&C and general behavior for EE&C.
Implementation Agency	National EE&C Center (NEEC)(budget, planning, distribution of textbooks), Power utilities (training)
Outline	1) NEEC creates and distributes the textbooks on EE&C, electricity safety and the environment to students directly or through power utilities. NEEC develops a school curriculum on EE&C consulting with MECA or PAEW. 2) NEEC plans the EE&C lecture for teachers and power utilities create the lecture. 3) Teachers who took the lecture in turn create a lecture for students using the EE&C textbook distributed from NEEC.

The NEEC creates and distributes the textbooks on EE&C so that the EE&C education is conducted smoothly in cooperation with power utilities. The following figure shows the implementation structure.

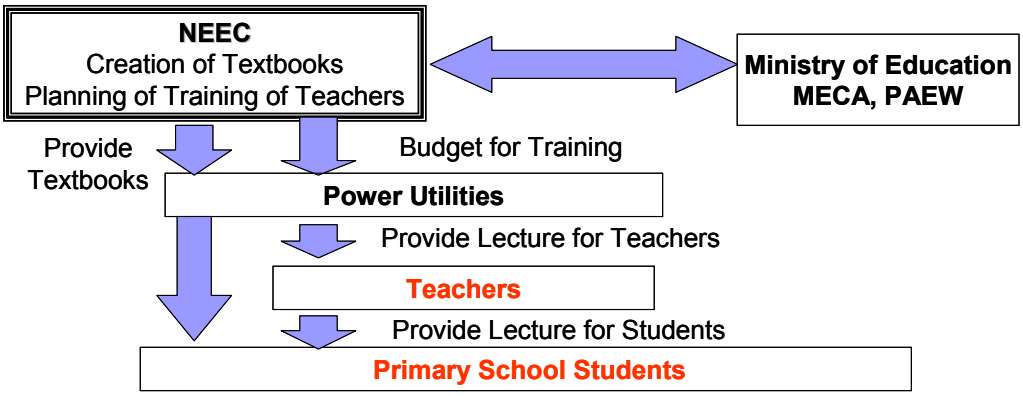


Figure 7- 20 Implementation Structure for National Education Curriculum Development and Training of Teachers

(iii) General Information on the Mandatory Program in EE&C Law

The following table shows the outline of the proposal for General Information on the Mandatory Program in EE&C Law.

Table 7- 19 Outline of General Information on Mandatory Program in EE&C Law

Items	Contents
Objective	NEEC creates and distribute pamphlets due to raising the awareness level on mandatory EE&C measures (EMS, MESL and EE&C Building Regulation).
Implementation Agency	National EE&C Center (NEEC)(planning, budget, textbook distribution), Power utilities (textbook distribution)
Outline	1) NEEC creates pamphlets for EMS, MESL and EE&C Building Regulations, and distributes factories, buildings and residences through power utilities. 2) The pamphlets are available to download soft data from the website.

The NEEC is an implementation agency to promote the mandatory programs which are stated in EE&C Law. The following figure describes the implementation structure.

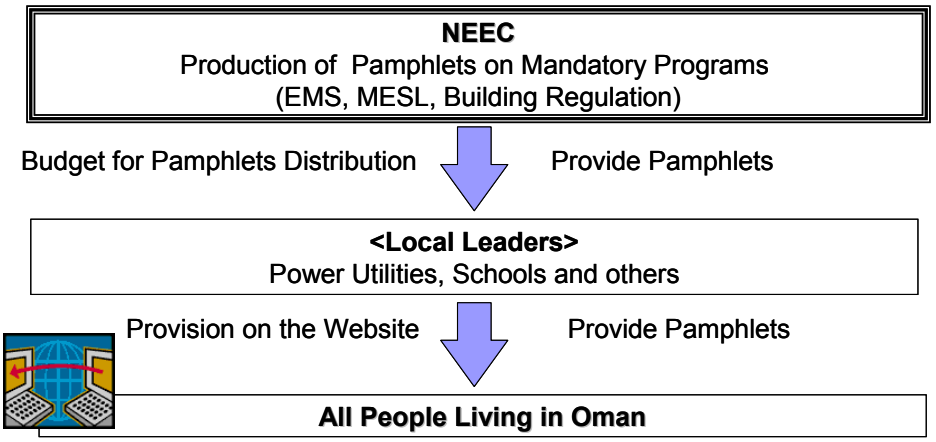


Figure 7- 21 Implementation Structure for General Information on Mandatory Program in EE&C Law

(iv) National EE&C Campaign

The following table shows the outline of the proposal for the National EE&C Campaign.

Table 7- 20 Outline of National EE&C Campaign

Items	Contents
Objective	In order to raise the awareness level, EE&C Awareness Month is established, and various campaign such as a media campaign, exhibition, mosque campaign and local events are planned/implemented.
Implementation Agency	National EE&C Center (planning, budget, implementation) , Power utilities (local event)
Outline	NEEC plans a campaign for EE&C Awareness Month. Media campaigns, mosque campaigns and exhibitions are implemented by mainly NEEC. Local events are implemented by power utilities.

It is important that a National EE&C Campaign is held for certain days called "EE&C Awareness Month" once in a year and that it takes place in the whole of Oman. The following figure shows the implementation structure.

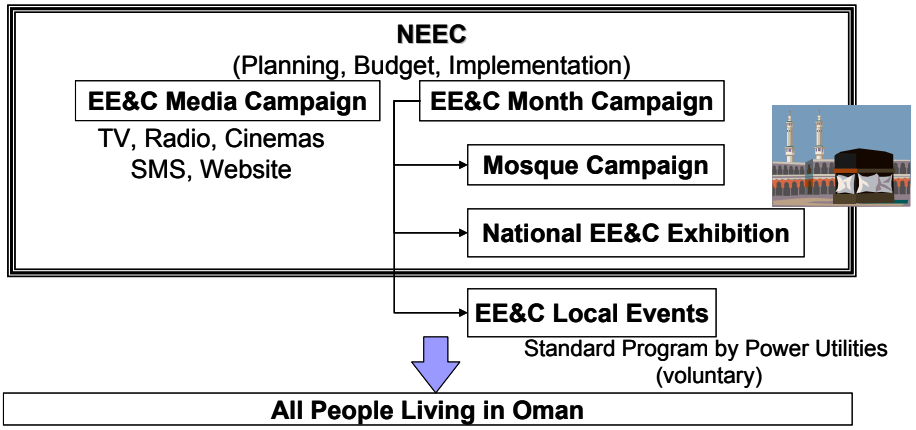


Figure 7- 22 Implementation Structure for National EE&C Campaign

(v) Study Tour to Power Facilities

The following table shows the outline of the proposal for the Study Tour to Power Facilities.

Table 7- 21 Outline of Study Tour to Power Facilities

Items	Contents
Objective	The Power Station provides information on how to produce electricity to make the participants such as students and neighborhoods understand the importance of EE&C.
Implementation Agency	National EE&C Center (planning, budget), power utilities(promotion), power station(implementation of study tour)
Outline	1) NEEC plans the study tour by agreeing with the power utilities. 2) Power utilities provide information on the study tour to schools and local communities. 3) Power stations or load dispatching center implements the study tour. NEEC covers transportation, lunch, and novelties for the participants so that power stations do not have to pay for it. 4) The study tour includes the introduction of environmental measures in the power station as part of the environmental education.

It is important for students and neighborhoods to become more familiar with EE&C through participation in the study tour. Due to increasing the number of participants, it is necessary to prepare food or provide small presents as an incentive. The following figure shows the implementation structure.

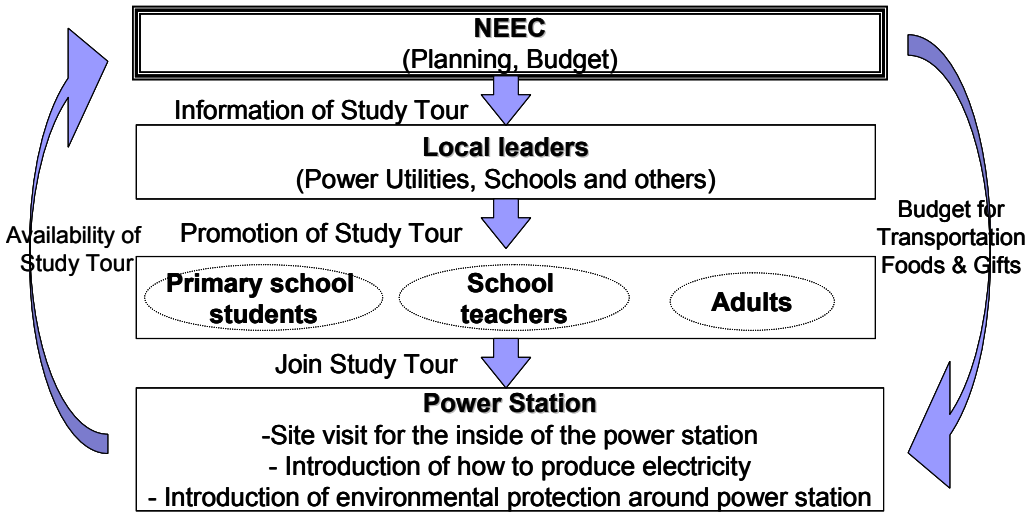


Figure 7- 23 Implementation Structure for Study Tour to Power Station

(c) Type C: Local Program

(i) EE&C Model Project

The proposed programs of Type C are the programs which power utilities implement willingly. As one example, the EE&C Model Project that MJEC first proposed to the JICA Study Team is introduced in this section as follows.

Table 7- 22 Outline of EE&C Model Project

Items	Contents
Objective	Power utilities select the model housing in each area and replace the appliances into new efficient ones. The target is to help residents understand the importance of EE&C by the reduction of power consumption (or reduction of electricity tariff) the importance of EE&C during the designated period when the residents attempt to adopt EE&C behavior.
Implementation Agency	Power utilities (planning, budget, implementation)
Outline	1) Power utilities purchase EE&C appliances within their budget and install them into the model housings. The residents are told to adopt EE&C behavior. 2) The residents understand EE&C by monitoring the effect of EE&C appliances, the effect of EE&C behavior and the change of power consumption and electricity tariffs. 3) After the model housing project, the residents report the effects of their project to the neighbors or other parties.

It is important to implement the model project in a local area even if it costs power utilities much to replace appliances or even if time has to be spent because the project can raise the awareness EE&C level of not only the residents of the project but also the whole neighborhood if the project succeeds. The following figure shows the implementation structure.

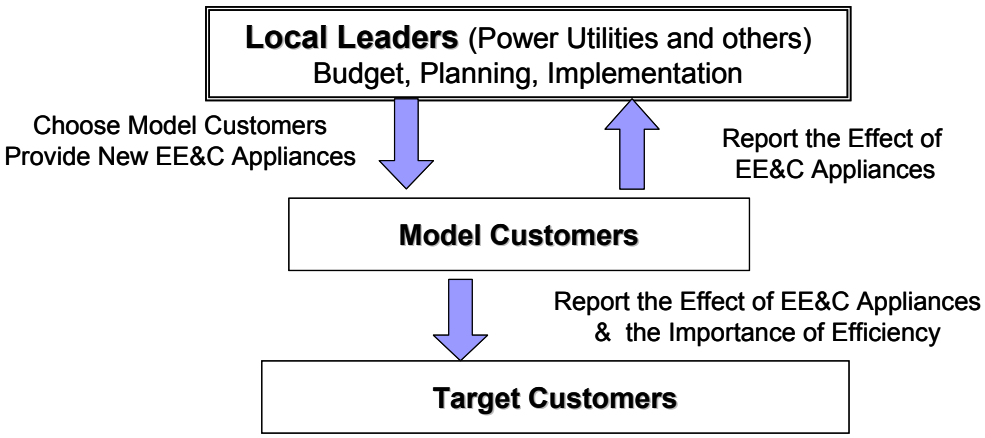


Figure 7- 24 Implementation Structure for EE&C Model Project

Chapter 8 Implementation Plan for Each EE&C Measure

With regards to the EE&C Measures described in the Chapter 7, the implementation plan has been proposed as follows. The following items are included in the proposed plan.

- Implementation Schedule
- Organization and Action Plan
- Outsourcing Work and Procurement Plan
- Budget Plan
- Related Sub-Programs

8.1 Overall Schedule and Milestones

The overall schedule for each EE&C measure and milestones are proposed as follows.

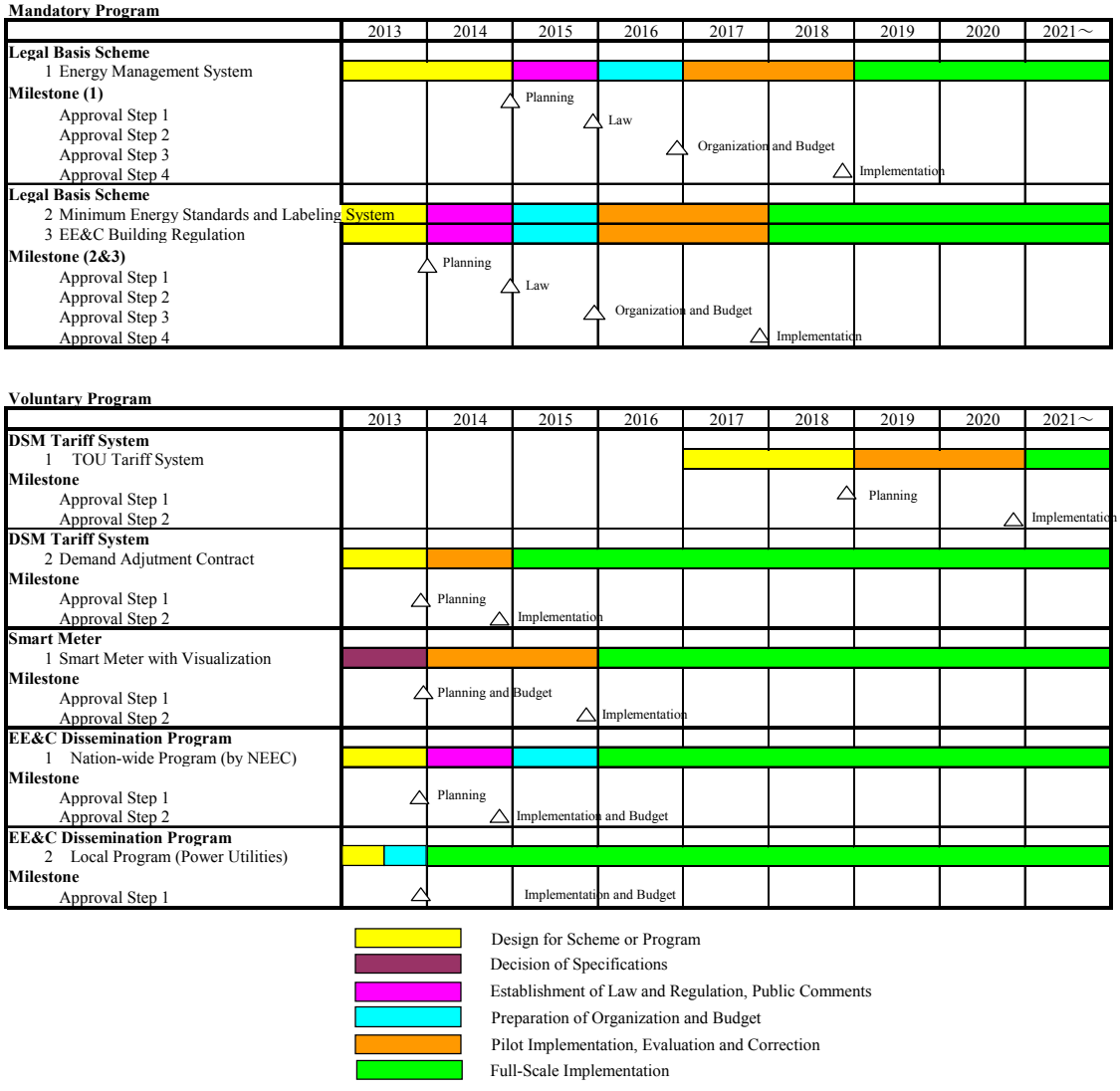


Figure 8- 1 Overall Schedule and Milestone

The following points were considered for creating the above schedule.

- Each EE&C measure basically implements per the order of the detailed scheme design, pilot implementation and full-scale implementation. The stage of the pilot implementation is a trial implementation in model areas or selected targets to evaluate whether the scheme has been smoothly executed before starting full-scale implementation. Through the pilot implementation, the original scheme is reviewed and some revisions are made reflecting the results of the review if necessary.
- A new organization, National EE&C Center (NEEC), is proposed to be established for the executing agency for the Energy Management System and the EE&C dissemination programs which are planned to be started in 2016. Prior to that time, PAEW is expected, as a preparatory body, to plan and prepare the scheme and programs.
- The mandatory programs such as Energy Management System, Minimum Energy Standards and Labeling System, EE&C Building Regulation and the establishment of a new organization require a legal basis and a one-year preparation period must be considered.

8.2 Individual Plan for Each EE&C Measure

8.2.1 Energy Management System

(1) Implementation Schedule

The implementation schedule of the Energy Management System (EMS) is shown below. In the discussion of the scheme of EMS described in Chapter 7, two options (options for management of only electricity and both electricity and fuel) were proposed. In this section, the option of managing both electricity and fuel, recommended by the JICA Study Team, has been adopted and a new organization (NEEC) has been established as the executing agency. The implementation plan has been proposed.

The EMS aims to begin pilot implementation from 2017 and full-scale implementation from 2019.

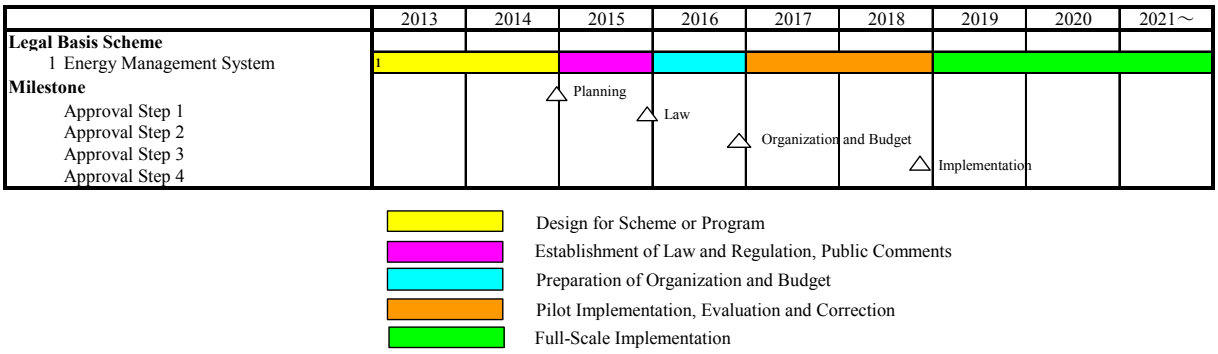


Figure 8- 2 Implementation Schedule for the Energy Management System

(2) Organization and Action Plan

By dividing the plan into 3 stages, namely a preparation period, a pilot implementation period and a full-scale implementation period, the organization and action plan will be proposed as follows.

PAEW is expected to take action during the preparation period until 2016 and then the tasks will be taken over to NEEC for the pilot implementation period in 2017. NEEC is expected to be established by 2016 as an executing agency for the implementation of nation-wide dissemination programs.

Table 8- 1 Organization and Action Plan

	Preparation Period	Pilot Implementation Period	Full-Scale Implementation Period
Duration	2013-2016	2017-2018	2019-
Executing Agency	PAEW	NEEC	NEEC
Main Tasks	• Detailed scheme design • Establishment of law and regulations • Establishment of organization and budget • Establishment of training facilities and national training course • Creation of database	• Pilot implementation (implementation, evaluation, review, revision, etc.) • Start of national training course	• Full-scale implementation

(3) Outsourcing Work and Procurement Plan

To implement according to the above tasks, the necessary outsourcing work and procurement plan has been proposed as follows.

Table 8- 2 Outsourcing Work and Procurement Plan

Outsourcing Work	Implementation Period	Main Contents	Expected Cost
Support for Detailed Scheme Design	2013-2014 (Preparation Period)	• Scoping designated consumers • Creation of operation manual for the scheme • Creation of energy management standards • Creation of energy audit standards	150,000 RO
Support for Creating Training Program	2013-2014 (Preparation Period)	• Creation of curriculum of training program • Study for the methodology of the creation of a certificate test	150,000 RO
Support for Establishment of Law and Regulations	2015 (Preparation Period)	• Creation of a draft law and regulations based on the detailed scheme design	20,000 RO
Support for Inspection	Every Year after 2019 (Full-Scale Implementation Period)	• Providing advice to inspectors when the inspectors go into the site	7,500 RO/year (30 sites/year)

Procurement	Implementation Period	Main Contents	Expected Cost
Training Center (Hands-on Facilities)	2015-2016 (Preparation Period)	• Installation of training facilities (boiler, compressor, pump, AC, etc.) • Creation of text books for training facilities	500,000 RO
	Every Year after 2017 (Pilot and Full-Scale Implementation Period)	• Implementation of training course using hands-on facilities (O&M)	25,000 RO/year
Database	2016 (Preparation Period)	• Creation of database	30,000 RO
	Every Year after 2017 (Pilot and Full-Scale Implementation Period)	• Maintenance of database	7,000 RO/year

(4) Schedule for Human Resources and Facilities

The schedule for human resources and facilities are proposed as follows (the annual schedule after 2022 is the same as 2021).

Table 8- 3 Schedule for Human Resources and Facilities

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Stage	**Preparation**				**Pilot**		**Full-Scale**		
Executing Agency	**PAEW**				**National EE&C Center**				
(Human Resources)									
Manager	1	1	1	1	1	1	1	1	1
General Staff	1	1	1	1	2	2	2	2	2
Data Arranger (Assistant)					2	2	2	2	2
(Outsourcing Work)									
Support for Detailed Scheme Design	1 set								
Support for Creating Training Program	1 set								
Support for Establishment of Law and Regulations				1 set					
Support for Inspection							1 set	1 set	1 set
(Facilities)									
Training Center (Hands-on Facilities and Operation)			1 set		O&M	O&M	O&M	O&M	O&M
Database				1 set	O&M	O&M	O&M	O&M	O&M

(5) Budget Plan

Based on the required human resources, outsourcing work and facilities, the necessary administration costs for the scheme has been calculated as follows.

Unit: RO

Table 8- 4 Budget Plan

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Stage	**Preparation**				**Pilot**		**Full-Scale**		
Executing Agency	**PAEW**				**National EE&C Center**				
(Human Resources)									
Manager	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000
General Staff	12,000	12,000	12,000	12,000	24,000	24,000	24,000	24,000	24,000
Data Arranger (Assistant)					12,000	12,000	12,000	12,000	12,000
(Outsourcing Work)									
Support for Scheme Design	75,000	75,000							
Support for Creating Training Program	75,000	75,000							
Support for Establishment of Law and Regulations				20,000					
Support for Inspection							7,500	7,500	7,500
(Facilities)									
Training Center (Hands-on Facilities and Operation)			250,000	250,000	25,000	25,000	25,000	25,000	25,000
Database				30,000	7,000	7,000	7,000	7,000	7,000
(Administration)									
Total Human Resources Costs x 30 %	10,800	10,800	10,800	10,800	18,000	18,000	18,000	18,000	18,000
Total (without Subsidy)	**196,800**	**196,800**	**296,800**	**346,800**	**110,000**	**110,000**	**117,500**	**117,500**	**117,500**

(6) Related Sub-Programs

To smoothly implement the scheme of EMS, relating sub-programs have been proposed as follows.

(a) Subsidy for Mandatory Energy Audit

(i) Objective

As mentioned in Chapter 7, it has finally been proposed that a mandatory energy audit will be conducted for all designated consumers once every 3 years.

The benefits by reducing electricity and fuel through EMS mainly belong to the government because domestic fuels can be traded at international prices. Such government benefits can be partially injected to designated consumers, who generate the benefits, for encouragement of EE&C activities. In this context, a government subsidy helps implement the costs of the mandatory energy audit.

(ii) Estimation of Energy Audit Costs

Costs for the energy audit are estimated as follows. For a factory energy audit, requiring 2 members is to be proposed because it is more complicated than a building energy audit.

Assuming the preparation of a questionnaire, a site survey (1 day), creating a report, and reporting to the site are included during the energy audit work, 3,900 RO for a factory site and 1,950 RO for a building site are estimated for the audit costs.

Table 8- 5 Estimation of Energy Audit Costs

Energy Audit Cost for a Factory Site

Work Item	Requirement	Man-Days	Unit Price RO/Day	Amount RO
Preparation	1 member x 2 days	2	300	600
Site Survey	2 members x 1 day	2	300	600
Creating Report	2 members x 2 days	4	300	1,200
Reporting to the Site	2 members x 1 day	2	300	600
			Sub-total	3,000
Administration			Sub-total x 30 %	900
			Total	3,900

Energy Audit Cost for a Building Site

Work Item	Requirement	Man-Days	Unit Price RO/Day	Amount RO
Preparation	1 members x 1 day	1	300	300
Site Survey	1 members x 1 day	1	300	300
Creating Report	1 members x 2 days	2	300	600
Reporting to the Site	1 members x 1 day	1	300	300
			Sub-total	1,500
Administration			Sub-total x 30 %	450
			Total	1,950

(iii) Consideration of a Government Subsidy Injection

In Chapter 7, the number of designated consumers at the first stage was proposed at 60 sites for the industry sector, 110 sites for the commercial sector and 150 sites for the government sector.

Assuming that such designated consumers take mandatory energy audits once every 3 years, the total annual costs for all the audits is estimated at 247,000 RO/year.

Table 8- 6 Annual Cost Estimation for Energy Audit

	Number of Audit	Unit Cost of Audit	Annual Costs
	per year	RO	RO
Industry	20	3,900	78,000
Commercial	36	1,950	71,500
Government	50	1,950	97,500
		Total	247,000

Required government subsidy by subsidy rates are shown below.

Table 8- 7 Required Government Subsidy by Subsidy Rates

	Rate: 100% RO	Rate: 75% RO	Rate: 50% RO
Frequency (1 time/3 years)	247,000	185,250	123,500

When the government subsidy rate is set at 75 %, the affordability for the government and designated consumers is studied as follows.

Nationwide Benefits: 12.5 million US$/year (10 US$/MMBtu is adopted for natural gas: refer to Chapter 6)

Out of which, 10 % of the benefits used for the budget of the government subsidy: 1.25 million US$

Money Saving by EE&C Actions in a Designated Consumer

Factory: 60,000 MMBtu x 1 % x 1.56 US$/MMBtu (domestic price) = 936 US$/year

Building: 4.2 GWh (final energy conversion from 50,000 MMBtu) x 1 % x 0.02 RO/kWh = 2,180 US$/year

Required Government Subsidy at a 75 % Subsidy Rate: 185,520 RO/year = 463,800 US$/year < 1.25 million US$/year

Burden of Factory: 3,900 RO x 25 % x 1/3 = 325 RO/year = 812 US$/year < 936 US$/year

Burden of Building: 1,950 RO x 25 % x 1/3 = 162 RO/year = 406 US$/year < 2,180 US$

According to the above calculation, the designated consumers (both factories and buildings) the money that can be saved by conducting EE&C activities encouraged by EMS exceeds the burden of the energy audit cost (at 75 % government subsidy) and thus to some degree affordability can be secured to some extent.

As for the factory, because the cost burden is nearly equal to the money saved, it might be better if the government subsidy rate is raised.

(iv) Budget Plan including the Government Subsidy

If the budget plan considers the government subsidy (subsidy rate: 75 %) as well for the mandatory energy audit (1 time in 3 year), the total administration cost is estimated to be as follows.

Table 8- 8 Budget Plan including Government Subsidy (Subsidy Rate: 75 %)

Unit: RO

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Stage	**Preparation**				**Pilot**		**Full-Scale**		
Executing Agency	**PAEW**				**National EE&C Center**				
Total (without Subsidy)	**196,800**	**196,800**	**296,800**	**346,800**	**110,000**	**110,000**	**117,500**	**117,500**	**117,500**
Subsidy Rate: 75 % Case					183,398	183,398	183,398	183,398	183,398
Total (with Subsidy)	**196,800**	**196,800**	**296,800**	**346,800**	**293,398**	**293,398**	**300,898**	**300,898**	**300,898**

(b) Good Practice Award

This program is undertaken to enhance awareness and encourage EE&C activities in each sector targeted by EMS. EMS can obtain periodical reports and energy audit reports from designated consumers. Utilizing this network, the regulatory body requests to apply for the program for the Good Practice Award. Some designated consumers who are interested in the program submit application forms to the regulatory body.

It is recommended from the perspective of the dissemination effects that the ceremony for the award is held as one of the events during the EE&C campaign period.

(c) Creation of Training Courses for General Engineers

The training courses for the qualification of Energy Manager, Energy Auditor and Energy Officer can be utilized for the training courses for general engineers by spinning off from the national training courses. It is also proposed that such training courses be free of charge during promotion periods.

These training courses for general engineers are expected to raise the utilization factor of hands-on facilities which are prepared for national training courses. Besides, if the training courses can receive trainees from foreign countries with training fees, the collected fees can be used for the operation costs.

There are some courses which can be made from the national training courses as follows.

- Basic Course for Energy Management (from the training course for the Energy Officer)
- Energy Management Practice Course (from the training course for the Energy Manager)
- Hands-on Facility Training Course (from the training course for the Energy Manager)
- Energy Audit Practice Course (from the training course for the Energy Auditor)

8.2.2 Minimum Energy Standards and Labeling System

(1) Implementation Schedule

The implementation schedule of the Minimum Energy Standards and Labeling System (MESL) is shown below. The MESL aims to start pilot implementation from 2016 and full-scale implementation from 2018.

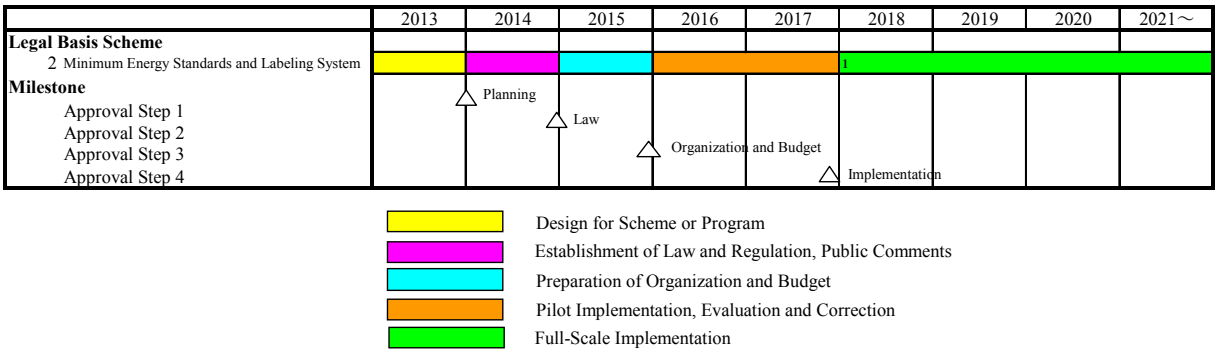


Figure 8- 3 Implementation Schedule for Minimum Energy Standards and Labeling System

(2) Organization and Action Plan

By dividing into 3 stages, namely a preparation period, a pilot implementation period and a full-scale implementation period, the organization and action plan is proposed as follows. In all the stages, MOCI plays a key role of the scheme.

Table 8- 9 Organization and Action Plan

	Preparation Period	Pilot Implementation Period	Full-Scale Implementation Period
Duration	2013-2015	2016-2017	2018-
Executing Agency	MOCI	MOCI	MOCI
Main Tasks	• Detailed scheme design • Establishment of test standards • Establishment of law and regulations • Establishment of organization and budget • Installation of AC test laboratory • Creation of database	• Pilot implementation (implementation, evaluation, review, revision, etc.) • Authorization of third party's laboratories	• Full-scale implementation

(3) Outsourcing Work and Procurement Plan

To implement according to the above tasks, necessary outsourcing work and a procurement plan are proposed as follows.

Table 8- 10 Outsourcing Work and Procurement Plan

Outsourcing Work	Implementation Period	Main Contents	Expected Cost
Support for Creating Test Standards	2014 (Preparation Period)	• Scoping designated products from the targeted appliances • Creation of test standards for the designated appliances	50,000 RO
Support for Designing AC Laboratory	2014 (Preparation Period)	• Detailed design for AC laboratory • Creation of specification for procurement	100,000 RO
Support for Establishment of Law and Regulations	2015 (Preparation Period)	• Creation of draft law and regulations based on the detailed scheme design	20,000 RO

Procurement	Implementation Period	Main Contents	Expected Cost
AC Laboratory	2016-2017 (Preparation Period)	• Test facilities (equipment and building)	1,000,000 RO
	Every Year after 2018 (Full-Scale Implementation Period)	• Maintenance cost for correction, etc.	30,000 RO/year
		• Implementation cost for testing (15 times x 4 days/time)	100,000 RO
Database	2015 (Preparation Period)	• Creation of database	30,000 RO
	Every Year after 2016 (Pilot and Full-Scale Implementation Period)	• Maintenance of database	7,000 RO/year

(4) Schedule for Human Resources and Facilities

The schedule for human resources and facilities has been proposed as follows (the annual schedule after 2022 is the same as 2021).

Table 8- 11 Schedule for Human Resources and Facilities

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Stage	**Preparation**			**Pilot**		**Full-Scale**			
Executing Agency	**MOCI**								
(Human Resources)									
Manager	1	1	1	1	1	1	1	1	1
General Staff	1	1	1	1	1	1	1	1	1
AC Test Staff				2	2	2	2	2	2
Data Arranger (Assistant)				1	1	1	1	1	1
(Outsourcing Work)									
Support for Creating Test Standards		1 set							
Support for Designing AC Laboratory		1 set							
Support for Establishment of Law and Regulations			1 set						
(Facilities)									
AC Laboratory				1 set		O&M	O&M	O&M	O&M
Database			1 set	O&M	O&M	O&M	O&M	O&M	O&M

(5) Budget Plan

Based on the required human resources, outsourcing work and facilities, the necessary administration costs for the scheme has been calculated as follows.

Table 8- 12 Budget Plan **Unit: RO**

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Stage	**Preparation**			**Pilot**		**Full-Scale**			
Executing Agency	**MOCI**								
(Human Resources)									
Manager	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000
General Staff	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
AC Test Staff				24,000	24,000	24,000	24,000	24,000	24,000
Data Arranger (Assistant)				6,000	6,000	6,000	6,000	6,000	6,000
(Outsourcing Work)									
Support for Creating Test Standards		50,000							
Support for Designing AC Laboratory		100,000							
Support for Establishment of Law and Regulations			20,000						
(Facilities)									
AC Laboratory				500,000	500,000	130,000	130,000	130,000	130,000
Database			30,000	7,000	7,000	7,000	7,000	7,000	7,000
(Administration)									
Total Human Resources Costs x 30 %	10,800	10,800	10,800	19,800	19,800	19,800	19,800	19,800	19,800
Total (without Subsidy)	**46,800**	**196,800**	**96,800**	**592,800**	**592,800**	**222,800**	**222,800**	**222,800**	**222,800**

(6) Related Sub-Programs

To smoothly implement the scheme of MESL, related sub-programs have been proposed as follows.

(a) Subsidy for Purchase of New Air Conditioner

(i) Objective

For customers who wish to purchase air conditioners with the minimum efficiency standard, the subsidy encourages high efficiency air conditioners to the purchasers.

(ii) Consideration of a Government Subsidy Injection

Necessity of government subsidy has been studied as follows.

Normal AC Price: 200 RO

Incremental Cost for High Efficiency AC: 200 RO x 30 % = 60 RO

Annual Electricity Consumption of Normal AC: 2.6 kW/unit x 8,760 hr x 32 % = 7,288 kWh

Energy Saving Effect of High Efficiency AC: 7,288 kWh x 23 % = 1,676 kWh

Annual Customer Savings: 1,676 kWh x 0.015 RO/kWh = 25 RO

Accumulated Money Saved in 3 Years: 75 RO > 60 RO

As shown above, assuming a high efficiency air conditioner (23 % reduction of electricity consumption from the normal air conditioner) requires an incremental cost at 60 RO/unit, the

incremental costs can be recovered within 3 years. The money saving effect for customers may be enough to purchase new high efficiency air conditioners without a subsidy.

However, the above case is based on the assumption that the existing air conditioner will be replaced at the end of its life span. For customers who are not able to recognize the replacement time, there is the possibility that the incentive program does not lead to replacements to high efficiency air conditioners.

As an incentive trigger leading to the replacement of existing air conditioners, a subsidy program will be proposed at the timing of full-scale implementation (for the first 2 years). The subsidy program can consider the fixed subsidy per unit and the subsidy which increases the amount according to the efficiency level (ex. 15 RO for 5 star AC, 12 RO for 4 star AC, etc.)

In case that the fixed subsidy of 15 RO is adopted for all high efficiency air conditioners, the necessary cost will be estimated as follows (estimated at the time of 2018).

Fixed Subsidy per Unit for High Efficiency AC: 15 RO

Number of Stock of Existing AC in Oman (estimation): 410,000 houses x 7 units/house = 2,870,000 units

Replacement Rate for Existing AC: 10 %/year = 287,000 units/year

Number of AC for New Houses in Oman (estimation): 9,000 houses x 7 units/house = 63,000 units

Annual Number of New AC Installation: 350,000 units (= 287,000 units + 63,000 units)

Required Annual Budget for Subsidy: 350,000 unit x 15 RO/unit = 5,250,000 RO = 13.1 million US$

Annual Monetary Benefit of the Scheme: 14.0 million US$ (refer to Chapter 6)> 13.1 million US$

(iii) Budget Plan including Government Subsidy

If the budget plan considers a government subsidy (fixed subsidy: 15 RO/unit) as well for the purchase of high efficiency air conditioners during 2 years, the total administration cost will be estimated as follows.

Table 8- 13 Budget Plan including Government Subsidy **Unit: RO**

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Stage	**Preparation**			**Pilot**		**Full-Scale**			
Executing Agency	**MOCI**								
Total (without Subsidy)	**46,800**	**196,800**	**96,800**	**592,800**	**592,800**	**222,800**	**222,800**	**222,800**	**222,800**
Subsidy: 15 RO/Unit (500,000 units/year)						5,250,000	5,250,000		
Total (with Subsidy)	**46,800**	**196,800**	**96,800**	**592,800**	**592,800**	**5,472,800**	**5,472,800**	**222,800**	**222,800**

(b) Receiving Business on the Efficiency Test of Air Conditioners from the Outside

The MOCI's test laboratory for air conditioners is basically proposed for random tests for air conditioners in the market and the correction of test facilities of the third party's laboratories. To raise the utilization factor of MOCI's laboratory, it is expected that MOCI receives orders for the efficiency tests (random tests or correction tests) from the third country's government agencies as a business. However, in order to prevent a conflict of interest, orders from manufacturers or importers who sell in the Oman market should be avoided.

8.2.3 EE&C Building Regulation

(1) Implementation Schedule

The implementation schedule of the EE&C Building Regulation is shown below. The EE&C regulation aims to start pilot implementation from 2016 and full scale implementation from 2018.

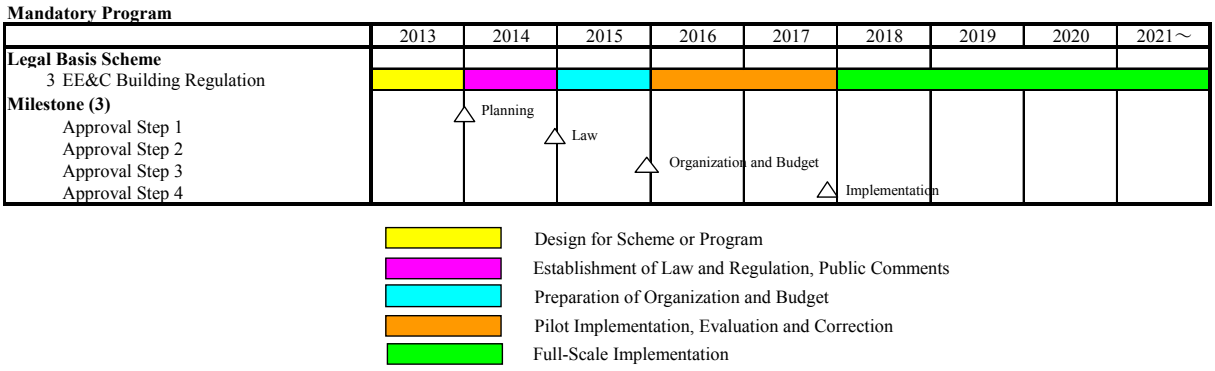


Figure 8- 4 Implementation Schedule for EE&C Regulation for Buildings

(2) Organization and Action Plan

With the period divided into three stages, namely the preparation period, the pilot implementation period and the full-scale implementation period, the organization and action plans for the corresponding stages are proposed as follows.

The National Committee of Building Code (NCBC) is expected to take actions during the preparation period until 2015, and then pilot implementation from 2016 will be conducted by Muscat Municipality. For the full-scale implementation, the governmental agencies in charge will be the executing agencies.

Table 8- 14 Organization and Action Plan

	Preparation Period	Pilot Implementation Period	Full-Scale Implementaiton Period
Duration	2013-2015	2016-2017	2018-
ExecutingAgency	NCBC	Muscat Municipality	Governmental Agencies in Charge
Main Tasks	• Detailed scheme design • Establishment of law and regulations • Establishment of organization and budget • Establishment of training facilities and national training course	• Pilot implementation (evaluation and review of the law and regulations will be conducted by NCBC.) • Start of national training course (by NEEC)	• Full-scale implementation

(3) Outsourcing Work Plan

To implement the above tasks, the necessary outsourcing work plan has been proposed as follows.

Table 8- 15 Outsourcing Work Plan

Outsourcing Work	Implementation Period	Main Contents	Expected Cost
Support for Detailed Scheme Design	2013-2015 (Preparation Period)	• Creating the climatic data for the standards • Adjustment and consideration of other items than the climatic data • Coordinating with the foreign building code institution which Oman will follow • Identifying and adding the necessary standards for materials which should be added to the standards	300,000 RO
Support for Creating Training Program	2014-2015 (Preparation Period)	• Creation of the curriculum of the training program	300,000 RO
Support for Establishment of Law and Regulations	2015 (Preparation Period)	• Creation of the draft law and regulations based on the detailed scheme design	20,000 RO
Support for Inspection	Every year after 2018 (Full-Scale Implementation Period)	• Direct cost for on-site inspections	15,000 RO/year (1,000 sites/year)

(4) Schedule for Human Resources and Outsourcing Work

The schedule for human resources and the outsourcing work have been proposed as follows. (The plan after 2022 is the same as the one of 2021.) The general staff during the pilot implementation and the full-scale implementation period is to deal with the increased document checks and on-site inspections in consideration of the regional situation of each municipality (e.g. Muscat Municipality holds 5 branch offices, etc.)

Table 8- 16 Schedule for Human Resources and Outsourcing Work

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Stage	**Preparation**			**Pilot**		**Full-Scale**			
Executing Agency: Building Regulation	**NCBC**			**Muscat Municipality**		**All the Municipalities**			
<Building Regulation>									
(Human Resources)									
Manager	1	1	1	1	1				
General Staff	1	1	1	5	5	31	31	31	31
(Outsourcing Work)									
Support for Detailed Design	1 set								
Support for Establishment of Law and Regulations			1 set						
Support for Inspection				1 set	1 set	1 set	1 set	1 set	1 set
Executing Agency: Material Standard Regulaiton	**MOCI**								
<Material Standard Regulation>									
General Staff			1	1	1	1	1	1	1

(5) Budget Plan

Based on the required human resources, outsourcing work, and the necessary costs for the

scheme has been calculated as follows (The plan after 2022 is not shown, since the annual plan after 2022 is the same as the one in 2021).

Table 8- 17 Budget Plan **Unit: RO**

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Stage	**Preparation**			**Pilot**		**Full-Scale**			
Executing Agency: Building Regulation	**NCBC**			**Muscat Municipality**		**All the Municipalities**			
(Human Resources)									
Manager	24,000	24,000	24,000	24,000	24,000				
General Staff	12,000	12,000	12,000	60,000	60,000	372,000	372,000	372,000	372,000
(Outsourcing Work)									
Support for Detailed Design	100,000	100,000	100,000						
Support for Establishment of Law and Regulations			20,000						
Support for Inspection				1,500	1,500	15,000	15,000	15,000	15,000
(Administration)									
Total Human Resources Costs x 30 % for Building Regulation	10,800	10,800	10,800	25,200	25,200	111,600	111,600	111,600	111,600
Executing Agency: Material Standard Regulaiton	**MOCI**								
(Human Resources)									
General Staff			12,000	12,000	12,000	12,000	12,000	12,000	12,000
(Administration)									
Total Human Resources Costs x 30 %	0	0	3,600	3,600	3,600	3,600	3,600	3,600	3,600
Total	146,800	146,800	182,400	126,300	126,300	514,200	514,200	514,200	514,200

(6) Related Sub-Programs

In order to smoothly operate EE&C Building Regulations, the related sub-programs are proposed as follows.

(a) Subsidy Program to Improve Thermal Performance

The targeted buildings per regulations will be obligated to introduce thermal insulation and high thermal performance windows (double-glazed windows etc.) in accordance with EE&C standards. However, for example, for the residential sector, it is difficult to recoup the additional investment cost of thermal insulation etc. solely from the benefits of electricity consumption reduction of air-conditioners, although it may depend on the expectation for the payback period (whether 30 years is acceptable, or 5 years is required.) In addition, the average houses (villas with a total floor area of 300 to 400 m^2) are not targeted by the regulations. Thus, an opinion was raised that a program which encourages them to adopt thermal insulation is necessary.

As a result, regardless of being targeted or not-targeted, financial support is recognized as necessary. Additional initial investment cost, benefit, payback periods for the average villas (whose total floor area is 300 m^2) were estimated as a trial calculation. In addition, an estimation, which was conducted at the beginning of the discussion, for the targeted large villas (total floor area: 600 m^2) is also shown for reference. However, the data for the trial estimation is rough and the estimation should be treated as only a guide.

(i) Method of the Trial Calculation

The trial calculation was estimated as follows; assuming a villa with or without thermal

insulation and double-glazed windows, additional initial investment cost and benefits (electricity cost reduction) are estimated. Based on the comparison of cost and benefits, payback periods and financial support (necessary subsidy level) are calculated. In addition, just for reference, the total subsidy cost for a nation is estimated by assuming the number of targeted houses.

(ii) Calculation Conditions for a House

The calculation conditions for a house are shown in the next table. The values are basically used after converting them into per unit. The data of the reduction effect in introducing the double-glazed windows were not found in the literature. The assumption in this calculation is that an additional 10 % will be achieved in addition to the effect of the thermal insulation.

Table 8- 18 Calculation Conditions

	Items	Values	Source
Electricity Consumption	Electricity consumption per floor area	0.44 kWh/day, m^2	Measured data by the JICA Study Team
	Electricity consumption pattern	Power demand pattern of residential sector	Estimated pattern by the JICA Study Team
Electricity Reduction	Thermal insulation	28 % of AC electricity consumption (cf: AC electricity consumption is approximately 39 % of the total electricity consumption.)	Simulation case study conducted for Saudi Arabia
	Double-glazed windows	+10% of AC electricity consumption reduction	No available data
Electricity Expense	Electricity tariff	10 Bz (up to 3,000 kWh/month) 15 Bz (3,000 to 5,000 kWh/month) 20 Bz (5,000 to 7,000 kWh/month) 25 Bz (7,000 to 10,000 kWh/month)	Tariff for residential sector of Oman
Initial cost	Initial cost per floor area	RO 190/m^2	Interview in Oman
	Initial cost rise by thermal insulation	2 % of the initial cost	Interview in Oman
	Initial cost rise by double-glazed windows	4 % of the initial cost	Interview in Oman

(iii) Calculation Results for a House

The calculation results for a house are shown in the next table. There are a combination of two cases for 300 m^2 and 600 m^2, and two cases for only a thermal insulation case (Case 1) and a thermal insulation and double-glazed window case (Case 2). Case 0 in the table shows the case without thermal insulation and a single glazing window. Initial investment costs, electricity consumption amount and electricity cost are shown.

Table 8- 19 Initial Cost, Electricity Consumption and Electricity Cost

	Initial Cost (RO)	Electricity Consumption (kWh/year)	Electricity Cost (RO/year)
<300 m^2>			
Case 0: No insulation	57,000	35,666	382
Case 1: Insulation only	57,000 + 1,140	31,809	327
Case 2: Insulation + double glazing	57,000 + 3,420	30,431	308
<600 m^2>			
Case 0: No insulation	114,000	71,333	993
Case 1: Insulation only	114,000 + 2,280	63,618	821
Case 2: Insulation + double glazing	114,000 + 6,840	60,863	768

The next table shows their payback periods and necessary subsidy level. As for the case of an average house of 300 m^2, for only thermal insulation, it takes 21 years for pay-back, and the subsidy of 600 RO is required for a 10-year payback period. The inclusion of double-glazed windows takes 46 years for payback, and it requires approximately 2,700 RO for a 10 year-payback and 2,000 RO for a 20 year-payback.

In the case of a large house, the thermal insulation recoups the additional cost relatively quickly in 13 years, but the inclusion of double-glazed windows will be approximately 30 years which is almost the same as the lifetime of a hose (assumed to be about 30 years).

Table 8- 20 Payback Periods and Subsidy Level (300 m^2)

	Initial cost rise (RO)	Electricity cost reduction (RO/year)	Payback period (years)	Subsidy level (RO)
Case1: Insulation only	1,140	55	21	0
			10	588
			5	864
Case2: Insulation and double glazing	3,420	74	46	0
			20	1,937
			10	2,679

Table 8- 21 Payback Periods and Subsidy Level (300 m^2)

	Initial cost rise (RO)	Electricity cost reduction (RO/year)	Payback period (years)	Subsidy level (RO)
Case1: Insulation only	2,280	172	13	0
			10	562
			5	1,421
Case2: Insulation and double glazing	6,840	225	30	0
			20	2,341
			10	4,590

(iv) Necessary Subsidy Amount as a Nation

At first, the subsidy for the targeted villas with more than 500 m^2 was considered. However, the local consultant survey indicated that approximately 20 % of the respondents have installed thermal insulation under the current situation without obligations, and the targeted are relatively wealthy. Thus, it was concluded that they are not targeted for the subsidy provisions. Furthermore, through the discussion, another option which provides incentives for not-targeted houses was raised to promote the introduction of thermal insulation etc. Thus, two estimations are shown here; 1) total subsidy for all, and the 2) subsidy for the targeted by regulation (for reference).

1) Calculation of Subsidy for All

The subsidy for all is calculated by assuming a 300 m^2 villa as representative due to lack of distribution data by building size. The total subsidy is calculated by multiplying the subsidy for a house, and the number of the targeted houses. The number of the targeted is assumed by using building permits statistics by plot size, since the distribution data by building size (by total floor area of buildings) are not available.

As already stated, assuming the payback period for the subsidy provision as being 20 years, the case of only thermal insulation can almost recoup the additional initial cost (21 years), and the case of thermal insulation and double-glazed windows requires 2,000 RO.

The total subsidy calculation is shown in the next table; one which uses the number of the plot size of 600 to 700 m^2 (which is assumed to correspond to the size of 300 m^2 of the total floor area), and the other which uses the number for all. The subsidy for the whole nation is 28 million RO.

In the case of a 10-year payback period, the subsidy for a house requires about 2,700 RO, and approximately 29 million RO as a nation.

These estimates consider only the new construction. It will be necessary to survey the building stock and limit the target or setting subsidy level according to the building size in the phase of the detailed design of the subsidy program.

Table 8- 22 Subsidy Amount for a Nation (Whole Nation)

	Subsidy per Building	Number of Buildings	Total subsidy as a Nation
Case 2: Insulation and double glazing	1,937 RO	6,530 (plot size: 600-700 m^2)	12.6 million RO
		14,500 (total)	28.0 million RO

2) Calculation of Subsidy for the Targeted Large Houses (Reference)

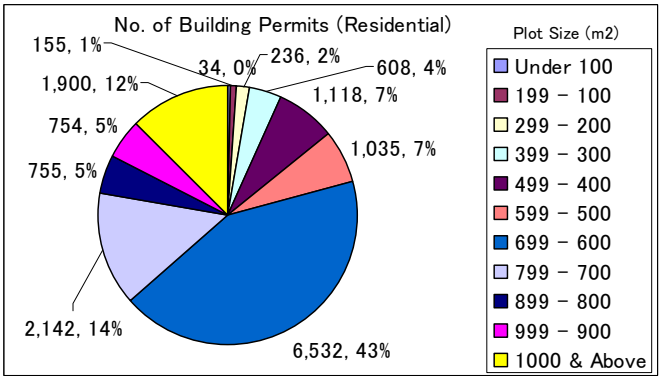
Although it is concluded that the subsidy will not be applied to the targeted large villas, the following shows, just for reference, a trial calculation of the total subsidy amount for a nation in the case of the subsidy provision for them. The subsidy per house is estimated by assuming the payback period of 10 years and 20 years. The number of the targeted* is estimated by

using the building permits statistics.

Note*

Number of the targeted for subsidy: ones with the plot size of more than 800 m^2 in the building permits statistics corresponding to the ones with the total floor area of more than 500 m^2

(Reason) In the building permit statistics, as for the residential sector, ones with a plot size of 600 to 700 m^2 covers about 40 % of the total. It is assumed that this class corresponds to the average villa (total floor area: 300 to 400 m^2), and the ones of 2 classes higher than this level correspond to the ones with a total floor area of more than 500 m^2.



(Source: Oman Building Permits Statistics)

Building Permits Statistics by Plot Size (2009)

Table 8- 23 Total Subsidy as a Nation (only the targeted by regulation)

Cases	Payback Period (years)	Subsidy per Building	Number of Buildings	Total Subsidy as a Nation
Case 1: Insulation only	10	562 RO	3,409	1.9 million RO
Case 2: Insulation and double glazing		4,590 RO		15.6 million RO
Case 1: Insulation only	20	0 RO	3,409	0 RO
Case 2: Insulation and double glazing		2,341 RO		8.0 million RO

The total subsidy is, at maximum, approximately 16 million RO. However, the number of the targeted is assumed based on the data by plot size due to lack of the data by total floor area, and the subsidy for a house is represented by only 600 m^2. Thus, the calculation above is only for reference.

(v) Implementation Framework for the Subsidy Program

In order to provide subsidies, it is necessary to check the buildings not only with the documents but also by conducting an on-site inspection confirming that the thermal insulation etc. has been installed properly in the building. This requires an evaluation institution which also conducts site inspections during construction. The evaluation institution and the fund

agency can be separate, or both can be covered by NEEC.

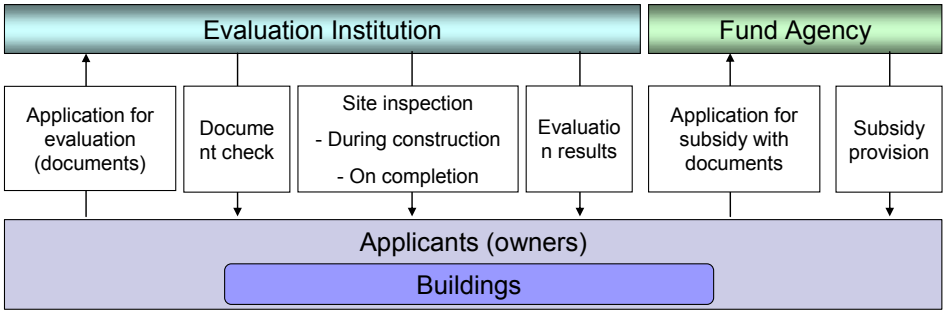


Figure 8- 5 Implementation Framework of Subsidy Program (Image)

(b) Training Programs

The introduction of EE&C standards requires that training programs be provided to related parties outside of general dissemination activities to announce regulation changes and its benefits through guidebooks, internet, seminars etc.

The targeted are, for example, building designers, engineering consultants, contractors, estate developers. Although international designers and engineering consultants would have no problem with the introduction of EE&C standards, local companies especially, would need training programs to adapt to the new concept, calculation method, and procedures.

The implementing institution for the training programs would be NEEC.

8.2.4 DSM Tariff System

(1) Implementation Schedule

The proposed schedule for implementing the DSM Tariff System (TOU Tariff and Demand Adjustment Contract) is shown in the following table. As discussed in Chapter 7, there was a comment from the Sub-Committee members that it is difficult to decide on the implementation timing of the TOU tariff because it requires the approval of the Council of Ministers, i.e. it is beyond the discretion of the stakeholders of this Study.

Therefore, this Study proposes to set the start of the full-scale implementation of the TOU tariff for 2021 tentatively, and to prioritize the implementation of the Demand Adjustment Contract (full-scale implementation slated for 2015). In the meanwhile, there is also the possibility that the plan to implement the Cost Reflective Tariff (CRT), which was considered by the AER but is currently suspended, will be revived, and as a result, the implementation of the TOU tariff, as a component of the CRT, can be accelerated.

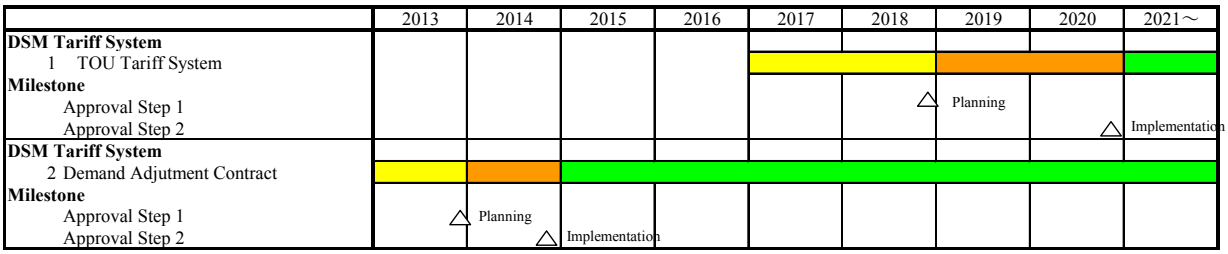


Figure 8- 6 Implementation Schedule for the DSM Tariff System

(2) Organization and Action Plan

This Study proposes the plan of the organizations and their activities for introducing the DSM tariff system in the stages of preparation, pilot implementation, and full-scale implementation as follows.

For both the TOU tariff and the Demand Adjustment Contract, the AER assumes responsibility for analyzing the load curve and the financial data as the baseline data for formulating the incentive rates, and the distribution companies are in charge of making contracts with customers. Therefore, it is not necessary to set up a new executing body.

Table 8- 24 Organization and Action Plan

		Preparatory Stage	Pilot Implementation	Full-scale Implementaiton
Duration	Demand Adjustment Contract	2013	2014	2015-
	TOU Tariff	2017-2018	2019-2020	2021-
Executing Agency		AER	AER DisCos	AER DisCos
MainTasks (AER)		• Analysis of load curve and costs of supply • Formulation of the incentive rates and tariff rates	• Supervision and evaluation of the pilot implementation • Coordination and procedures for approval within the Government for full-scale implementation (TOU tariff only)	• Monitoring of the status • Review of the peak load reduction effect • Revision of the rates and contract conditions (when needed)
	(DisCos)		• Pilot implementation • Reporting on the progress	• Announcement to customers • Contracting • Reporting on the status

(3) Outsourcing Work and Procurement Plan

This Study proposes a procurement plan for the outsourced works and the facilities that are necessary for the implementation of the aforementioned activities as follows. The costs of procuring the facilities necessary for implementing the DSM tariff, such as installing the digital meters and upgrading the billing system, are not counted here. This Study assumes that these facilities will be introduced independently regardless of the DSM tariff implementation, because their costs can be recovered by the reduction of the distribution system loss only.

Table 8- 25 Outsourcing Work and Procurement Plan

Outsourced Works	Implementation Period	Main Contents	Expected Costs
Program Formulation	< Demand Adjustment Contract > 2013 (Preparatory) < TOU Tariff > 2017-2018 (Preparatory)	• Technical assistance for data analysis that serves for formulating the DSM tariff system	50,000 RO
Pilot Project Evaluation	< Demand Adjustment Contract > 2014 (Pilot) < TOU Tariff > 2019-2020 (Pilot)	• Technical assistance for designing and the pilot project and evaluating the results of project implementation	50,000 RO

Procurement	Implementation Period	Main Contents	Expected Cost
Installing the Digital Meters	< Demand Adjustment Contract > 2014-(Pilot and Full-scale Implementation) < TOU Tariff > 2017-(Pilot and Full-scale Implementation)	• Installation of the digital meters compatible with the DSM tariff for eligible customers	Not counted (to be introduced independently regardless of DSM tariff implementation)
Upgrading the Billing System	< Demand Adjustment Contract > 2014-(Pilot and Full-scale Implementation) < TOU Tariff > 2017-(Pilot and Full-scale Implementation)	• Upgrading the system for calculating the customer billing to be compatible with the DSM tariff (DisCos)	

(4) Schedule for Human Resources and Facilities

The schedule for human resources and the facilities are proposed as follows (the annual schedule after 2022 is the same as 2021).

Table 8- 26 Schedule for Human Resources and Facilities

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Stage: Demand Adjustment Contract	Preparation	Pilot	Full-Scale						
Executing Agency	AER								
(Human Resources)									
Manager	1	1	1						
Load Analysis	2	2	1						
Financial Analysis	2	2	1						
(Consulting Work)									
Programme Formulation	1 set								
Pilot Project Evaluation		1 set							
Stage: TOU Tariff					Preparation		Pilot		Full-Scale
Executing Agency					AER				
Manager					1	1	1	1	1
Load Analysis					2	2	2	2	1
Financial Analysis					2	2	2	2	1
(Outsourcing Work)									
Programme Formulation					1 set				
Pilot Project Evaluation							1 set		
(Implementation)	DisCos								
Managers		*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
Customer Relations		*30*	*30*	*30*	*30*	*30*	*100*	*100*	*100*
(Facilities)	DisCos								
Digital Meters Installation		500 sets	O&M	O&M	O&M	O&M	1,000 sets	O&M	O&M
Billing System Upgrading		5 sets	O&M	O&M	O&M	O&M	O&M	O&M	O&M

(5) Budget Plan

Based on the staffing, outsourced works, and facilities procurement plans, this Study summarizes the necessary costs for implementing the DSM tariff system in the following table. The necessary costs after 2022 are supposed to be the same as those in 2021, thus they have been omitted in this table. This Study assumes that the contracting works of DisCos can be covered by the existing staff resources and that no additional staffing costs have accrued. This Study also assumes that the costs for procuring the facilities can be recovered by the reduction of the distribution system loss, thus these costs are not counted in this budget plan.

Table 8- 27 Budget Plan **Unit: RO**

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Stage: Demand Adjustment Contract	Preparation	Pilot	Full-Scale						
Executing Agency: Demand Adjustment Contract	AER								
(Human Resources)									
Manager	24,000	24,000	24,000						
Load Analysis	24,000	24,000	12,000						
Financial Analysis	24,000	24,000	12,000						
(Outsourcing Work)									
Programme Formulation	50,000								
Pilot Project Evaluation		50,000							
Stage: TOU Tariff					Preparation		Pilot		Full-Scale
Executing Agency: TOU Tariff					AER				
(Human Resources)									
Manager					24,000	24,000	24,000	24,000	24,000
Load Analysis					24,000	24,000	24,000	24,000	12,000
Financial Analysis					24,000	24,000	24,000	24,000	12,000
(Outsourcing Work)									
Programme Formulation					50,000	50,000			
Pilot Project Evaluation							50,000	50,000	
(Implementation)	DisCos								
Managers		-	-	-	-	-	-	-	-
Customer Relations		-	-	-	-	-	-	-	-
(Facilities)	DisCos								
Digital Meters Installation		-	-	-	-	-	-	-	-
Billing System Upgrading (incl.staff training)		-	-	-	-	-	-	-	-
(Administration)									
Total Human Resources Costs x 30 %	36,600	36,600	14,400		36,600	36,600	36,600	36,600	14,400
Total	**158,600**	**158,600**	**62,400**	**0**	**158,600**	**158,600**	**158,600**	**158,600**	**62,400**

8.2.5 Smart Meters with a Visual Breakdown of Electricity Consumption

(1) Implementation Schedule

The proposed schedule for implementing the visualization of electricity consumption is shown in the following figure. The design and development of the system will be performed in 2013. Following this, the pilot project will be started from 2014, and full-scale implementation will begin from 2016.

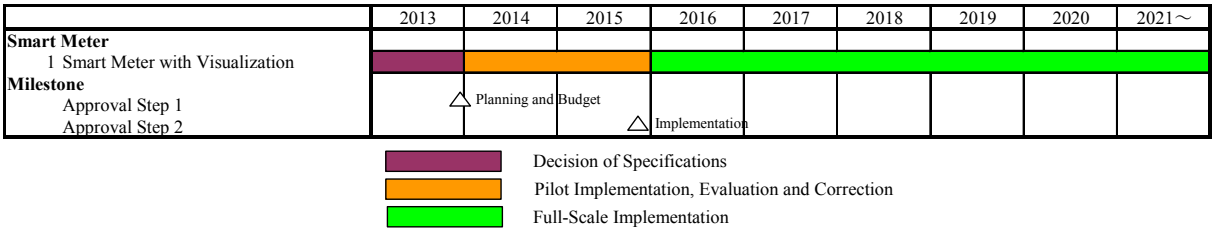


Figure 8- 7 Implementation Schedule for Smart Meters with a Visual Breakdown of Electricity Consumption

(2) Organization and Action Plan

This Study proposes the plan of organizations and their activities to introduce the visual breakdown of electricity consumption in the stages of preparation, pilot implementation, and full-scale implementation as follows.

The EHC assumes responsibility for development and the operations of the visualization system of electricity consumption.

Table 8- 28 Organization and Action Plan

	Preparatory Stage	Pilot Implementation	Full-scale Implementation
Duration	2013	2014-2015	2016-
Executing Agency	EHC	EHC	EHC
Main Tasks	• Development of visualization system of electricity consumption	• Supervision and evaluation of the pilot implementation	• Monitoring of status • Revision of the system (when needed) • Announcement to customers

(3) Outsourcing Work and Procurement Plan

This Study proposes the plan to procure outsourced works and the facilities that are necessary to implement the aforementioned activities as follows.

Table 8- 29 Outsourcing Work and Procurement Plan

Outsourcing Work	Implementation Period	Main Contents	Expected Cost
Development of a visualization system of electricity consumption	2013 (Preparatory)	• Development of visualization system of electricity consumption (Software)	50,000 RO
Procurement	**Implementation Period**	**Main Contents**	**Expected Cost**
Servers for the visualization system	2014-(Pilot and Full-scale Implementation)	• Providing hourly electricity consumption from MDMS to customers via internet (Hardware)	Initial Cost : 50,000 RO (Renewed every 4 years) OM Cost : 5 % of CAPEX

(4) Schedule for Human Resources and Facilities

The schedule for human resources and facilities are proposed as follows (the annual schedule after 2022 is the same as 2021).

Table 8- 30 Schedule for Human Resources and Facilities

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Stage	Preparation	Pilot		Full-Scale					
Executing Agency	EHC								
(Human Resources)									
Manager	1	1	1						
General Staff	1	1	1						
(Outsourcing Work)									
Support for System Design	1 set								
(Facilities)									
Visualizaton System (Server)		1set	O&M	O&M	O&M	O&M	O&M	O&M	O&M

(5) Budget Plan

Based on the staffing plans, outsourced works, and facilities procurement, this Study summarizes the necessary costs to implement the visualization system of electricity consumption in the following table. The necessary costs after 2022 are supposed to be the same as those in 2021 and thus are omitted in this table. This Study assumes that the costs for procuring the facilities can be recovered by the reduction of distribution system losses, thus these costs are not counted in this budget plan.

Unit: RO

Table 8- 31 Budget Plan

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Stage	Preparation	Pilot		Full-Scale					
Executing Agency	EHC								
(Human Resources)									
Manager	24,000	24,000	24,000						
General Staff	12,000	12,000	12,000						
(Outsourcing Work)									
Support for System Design	50,000								
(Facilities)									
Visualizaton System (Server)		50,000	2,500	2,500	2,500	50,000	2,500	2,500	2,500
(Administration)									
Total Human Resources Costs x 30 %	10,800	10,800	10,800						
Total	**96,800**	**96,800**	**49,300**	**2,500**	**2,500**	**50,000**	**2,500**	**2,500**	**2,500**

(6) Related Sub-Programs

In order to implement EE&C measures using smart meters, this Study proposes the related sub-program of meter inspection system as follows.

(a) Objective

As mentioned in Chapter 4, distribution companies inspect meter accuracy when customers doubt meter accuracy and request that distribution companies inspect them. However, because these inspections are conducted by distribution companies, the customers may doubt the inspection results.

Besides, there is no periodical inspection system in Oman, and there are many meters that have not been replaced for a long time and distribution companies may not notice the inaccuracy of those meters. In general, electromagnetic meters used for a long time tend to indicate less than their true values, so that it may be the cause of non-technical losses. In order to improve this situation, a periodical meter inspection system is recommended in addition to a special inspection requested from customers.

(a) Outline of Inspection System

The image of the inspection system is shown in the following figure. In addition to type testing and testing during production, a periodical inspection (every 10-15 years) after installation is recommended. The special inspections requested by customers are also needed.

The aforementioned activities are recommended to be carried out by a neutral third party outside of the distribution companies.

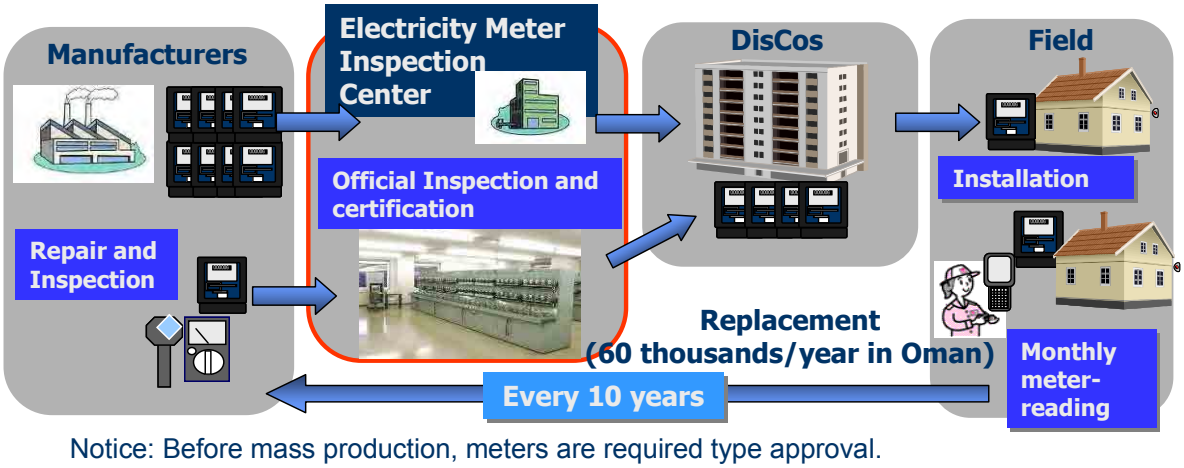


Figure 8- 8 Meter Inspection System (Image)

8.2.6 EE&C Dissemination Program

(1) Implementation Schedule

The following table shows the implementation schedule of the EE&C Dissemination Program. As described in Chapter 7, the programs are categorized into three types of programs according to the organizational structure such as the "Type A: National Program" where the program works more efficiently if it is implemented nation-wide, "Type B: National & Local Collaboration Program" where the program works more efficiently if it is implemented in collaboration with the central government and the local leaders, and the "Type C: Local Program" where the program works more efficiently if it is implemented in a local area. Type A and Type B are expected to begin implementation in 2016 after the establishment of National EE&C Center (NEEC).

Regarding the establishment of NEEC, as for Type A and B, it is necessary to establish new law and regulations. On the other hand, regarding Type C, it depends on the decision by power utilities for the implementation.

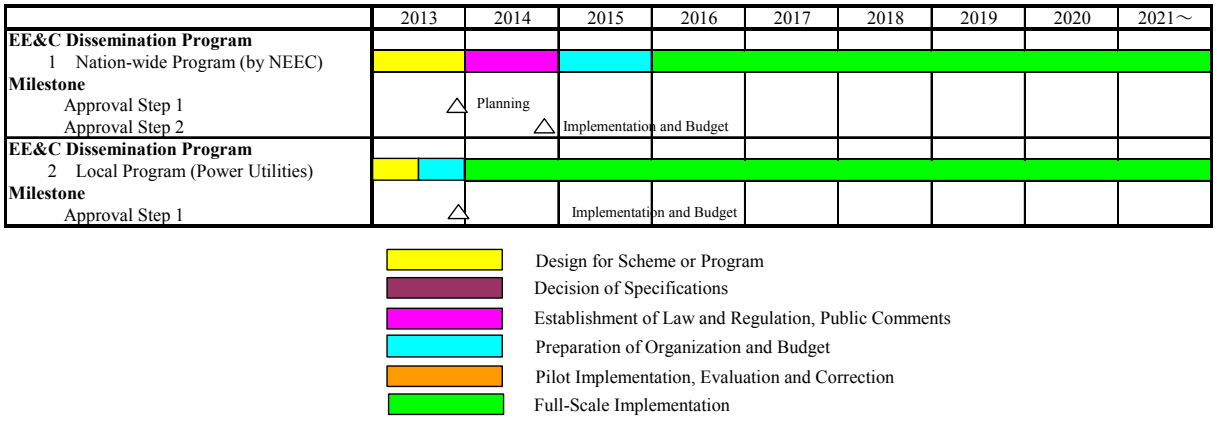


Figure 8- 9 Implementation Schedule for EE&C Dissemination Program

(2) Organization and Action Plan

The organization and the action plan for both stages of the "Preparation Stage" and the "Full-scale Implementation Stage" are proposed in the following section.

The preparation stage is set until 2016, and the main implementation organization is PAEW. Before the start of the pilot study in 2017, PAEW will transfer over their duties to NEEC. NEEC will be established in 2016 as the implementation organization for the EE&C Dissemination Program.

Table 8- 32 Organization and Action Plan

	Preparation Stage		Full-Scale Implementation Stage
Category	National/Local Collaboration Program (Type A, Type B)	Local Program (Type C)	
Period	2013-2015	2013-2014	National (A,B): 2016- Local (C): 2014-
Implemenation Organization	PAEW	Power Utilities and others	NEEC
Main work	• Design for Scheme or Program • Establishment of Law and Regulations • Preparation of Organization and Budget	• Design for Scheme or Program • Establishment of Law and Regulation	• Full-scale Implementation

(3) Schedule for Human Resources and Facilities

The human resources and facilities plan is shown in the following table (the annual schedule after 2022 is the same as 2021). In the preparation stage which is planned until 2015, the Type A (National Program) and Type B (National/Local Collaboration Program) are mainly managed by PAEW. Under the full-scale implementation stage which is started after 2016, all Type A and B programs are managed by NEEC. Regarding the Type C programs, the budget plan and the personnel plan are decided at the discretion of power utilities. The detailed plan for Type C is not described in this section. Section 8.3 shows the breakdown of the human resource plan for NEEC.

Table 8- 33 Schedule for Human Resources and Facilities

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Stage	**Preparation**			**Full-Scale**					
Executing Agency	**PAEW**			**National EE&C Center**					
(Human Resources)									
Chairman				1	1	1	1	1	1
Manager	1	1	1	4	4	4	4	4	4
General Staff	1	1	1	8	8	8	8	8	8
Assistant				7	7	7	7	7	7
(Outsourcing Work)									
Support for Establishment of Law and Regulations		1 set							
(Program Costs)									
All the Programs			1 set	1 set	1 set	1 set	1 set	1 set	1 set

(4) Budget Plan

The results of the cost estimation for the EE&C Dissemination Program based on the personnel plan is shown in the following table (the costs during and after 2022 are not shown in the table because it is estimated to be the same figure in 2021).

In the preparation stage, it is calculated with the value of the PAEW budget, and in the full-scale stage, it is estimated with the value of the NEEC budget.

Table 8- 34 Budget Plan **Unit: RO**

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Stage	**Preparation**			**Full-Scale**					
Executing Agency	**PAEW**			**National EE&C Center**					
(Human Resources)									
Chairman				48,000	48,000	48,000	48,000	48,000	48,000
Manager	24,000	24,000	24,000	96,000	96,000	96,000	96,000	96,000	96,000
General Staff	12,000	12,000	12,000	96,000	96,000	96,000	96,000	96,000	96,000
Assistant				42,000	42,000	42,000	42,000	42,000	42,000
(Outsourcing Work)									
Support for Establishment of Law and Regulations		20,000							
(Program Costs)									
Program Preparation and Implementation				2,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
(Administration)									
Total Human Resources Costs x 30 %	10,800	10,800	10,800	84,600	70,200	70,200	70,200	70,200	70,200
Total	**46,800**	**66,800**	**46,800**	**2,318,600**	**1,304,200**	**1,304,200**	**1,304,200**	**1,304,200**	**1,304,200**

8.3 Concept for the Organizational Structure of NEEC

The implementation structure and the organizational structure of NEEC are described in this section.

(1) Implementation Structure of NEEC

The Study Team held a discussion with the counterpart on the implementation structure of NEEC, focusing on that NEEC should be able to manage both the targets of electricity and fuel, and also that NEEC should be the main implementation organization for EE&C Dissemination Program, providing the subsidy and Energy Management System.

The three options for the structure are proposed from the Study Team. However, it was difficult to decide the best structure for all stakeholders during the Study because further intimate discussion among the stakeholders is necessary.

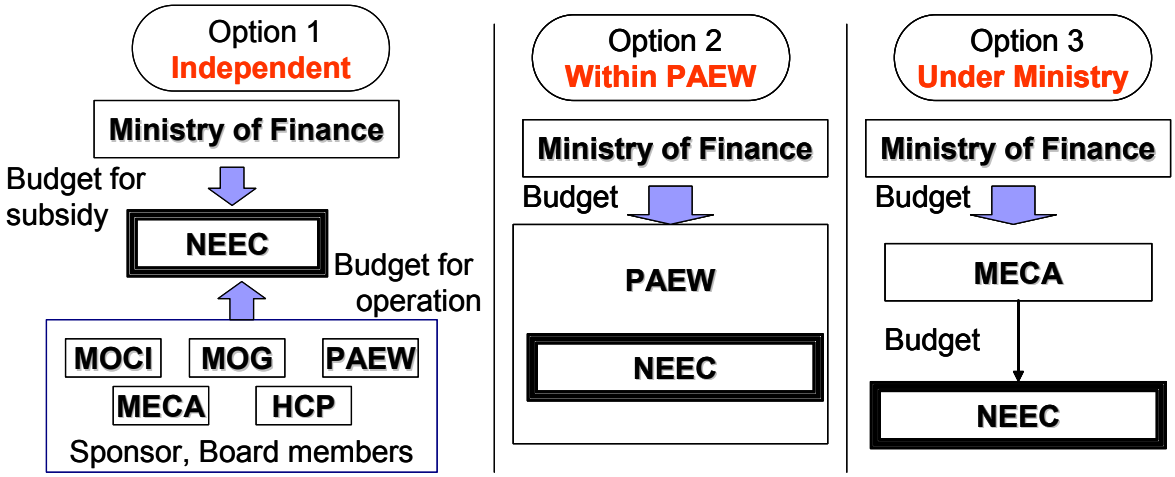


Figure 8- 10 Three Options for the Implementation Structure of NEEC

(a) Option 1

Option 1 is that NEEC is expected to become an independent organization similar to SEEC.

- Budget for NEEC operation: provided from MOCI, MOG, MECA, PAEW, Higher Council of Planning (HCP) and other stakeholders,
- Board of NEEC: composed of board members of related agencies/organizations,
- Budget for subsidies: funds will be established with financial support from the Ministry of Finance. NEEC will provide subsidies to applicants utilizing the funds. The operations budget for NEEC is based on the sponsors,
- Legal basis: the laws and regulation for a new organization, NEEC are necessary to be established.

(b) Option 2

Option 2 is that PAEW will take charge of NEEC.

- Budget for NEEC operations and subsidies: distributed from the Ministry of Finance through PAEW.
- Legal basis: the laws and regulation of PAEW need to be modified.

(c) Option 3

Option 3 is that NEEC will be established under a certain ministry. For example, NEEC is established under MECA which is a neutral organization that covers both electricity and fuel.

- Budget for NEEC operations and a subsidy: provided by the Ministry of Finance.
- Legal basis: the law and regulation of MECA needs to be modified.

(2) Organizational Structure of NEEC

The following table shows the proposal for the organizational structure of NEEC. Each division and group is composed of permanent personnel such as 1 Manager (M), 1-2 General Staff (G) and 1-2 Assistant Staff (AS). Totally it is estimated 24 permanent staffs.

Table 8- 35 Outline of the NEEC Organizational Structure

Division/Group	Personnel Plan	Description
Chairman	1 Chairman	Chief executive of all activities
Board	1 Board Member from each related agency/organization	Discuss/decide on the important matter
Administration and Management Division	1 Manger, 2 General Staff, 1 Assistant Staff	• Settling of accounts • Management of permanent staff and outsourced staff
National EE&C Training Division	1 Manager, 1 Assistant Staff	• Planning and operation of training programs for school teachers, energy managers, architects, constructors, building owners
Financial Support Division	1 Manager, 1 General Staff, 2 Assistant Staff	• Screening/Providing of subsidy for energy audit, purchase of high-efficient AC or other appliances
National Dissemination Division	1 Division Manager -Awareness & Monitoring Survey Group: 1 Group Manager, 1 Assistant Staff, -EE&C Award Group: 1 Group Manager,1 Assistant Staff, -EE&C Exhibition Group: 1 Group Manager, 1 Assistant Staff, -EE&C Information Group: 1 Group Manager, 1 Assistant Staff	• Planning and operation of dissemination programs for each measure
Administration of EMS Division	1 Manager, 2 General Staff, 2 Assistant Staff	• Check and evaluation of periodical report for Energy Management System

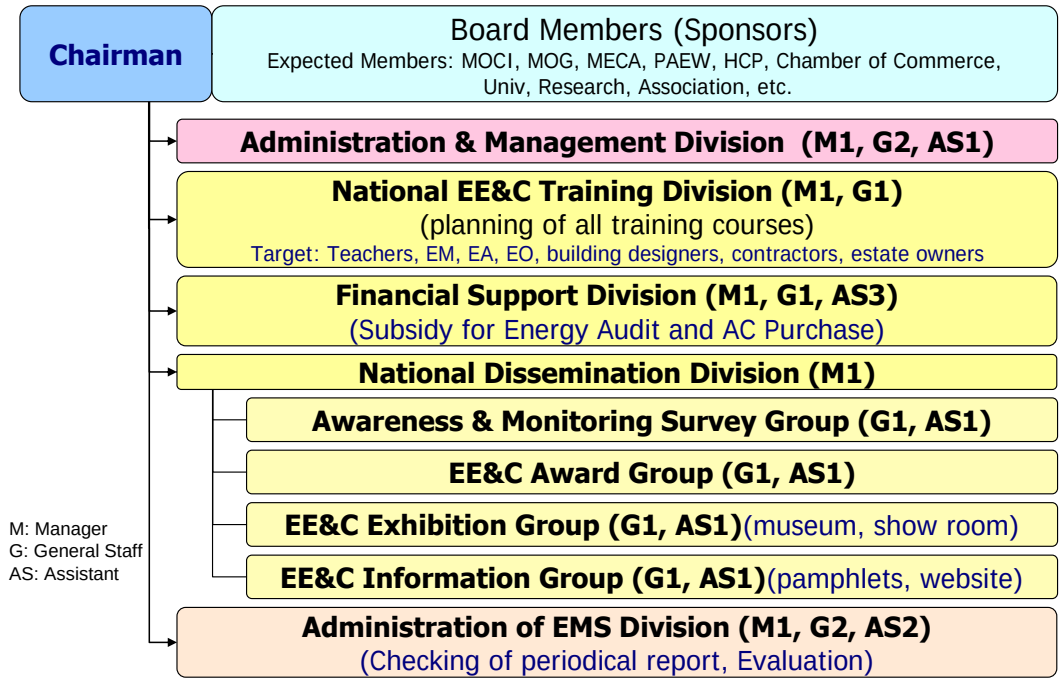


Figure 8- 11 Draft Organizational Structure of NEEC

8.4 Implementation Cost of EE&C Measures (Summary)

The implementation schedules and budget plans of abovementioned EE&C measures are summarized as follows (the annual schedule after 2022 is the same as 2021).

Table 8- 36 Implementation Cost (Summary) (Unit: RO)

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Energy Management System (EMS)									
PAEW	196,800	196,800	296,800	346,800					
NEEC					110,000	110,000	117,500	117,500	117,500
Minimum Energy Standards and Labeling (MESL)									
MOCI	46,800	196,800	96,800	592,800	592,800	222,800	222,800	222,800	222,800
EE&C Building Regulation (EBR)									
NCBC	146,800	146,800	166,800						
Muscat Municipality				110,700	110,700				
All the Municipalities						498,600	498,600	498,600	498,600
MOCI			15,600	15,600	15,600	15,600	15,600	15,600	15,600
DSM Tariff System (DTS)									
AER	158,600	158,600	62,400		158,600	158,600	158,600	158,600	62,400
Smart Meter (SM)									
EHC	96,800	96,800	49,300	2,500	2,500	50,000	2,500	2,500	2,500
EE&C Dissemination Program (EDP)									
PAEW	46,800	66,800	46,800						
NEEC				2,318,600	1,304,200	1,304,200	1,304,200	1,304,200	1,304,200
Total Cost (without Subsidy)	692,600	862,600	734,500	3,387,000	2,294,400	2,359,800	2,319,800	2,319,800	2,223,600
Subsidy for EMS					183,398	183,398	183,398	183,398	183,398
Subsidy for MESL						5,250,000	5,250,000		
Total Cost (with Subsidy)	692,600	862,600	734,500	3,387,000	2,477,798	7,793,198	7,753,198	2,503,198	2,406,998

Chapter 9 Scenario Analysis for EE&C Effects

9.1 Power and Energy Demand of Baseline

In this Chapter, the JICA Study Team aims to analyze the future EE&C effects following the introduction of EE&C measures. As for the analysis methodologies, EE&C effects are defined by the difference of the power demand between "With EE&C measures" and "Without EE&C measures".

In "Section 5.2 Power and Energy Demand Forecasts", the future power and energy demands, peak demands and primary energy demands without EE&C measures as a Baseline are forecasted. The contents are in the following tables.

Table 9- 1 Power Demands by Sector (Baseline)

Sector	Unit	2010	2012	2015	2020	2025	2030	2035
Total	GWh	19,200	22,270	26,040	33,610	41,380	49,790	59,770
Agriculture	GWh	210	260	300	370	430	470	520
Industry	GWh	1,540	2,810	3,540	5,210	6,960	8,870	11,270
Commercial	GWh	3,470	4,150	5,410	7,580	9,810	12,390	15,410
Government	GWh	2,390	2,690	3,080	3,860	4,660	5,640	6,830
Street light	GWh	120	140	180	230	270	300	320
Residential	GWh	8,400	9,080	10,930	13,000	15,110	17,140	19,440
T/D loss	GWh	3,070	3,140	2,600	3,360	4,140	4,980	5,980

(Source: JICA Study Team)

Table 9- 2 Growth Rates of Power Demands by Sector (Baseline)

Sector	Unit	15/10	20/15	25/20	30/25	35/30	20/10	35/20	35/10
Total	%	6.3	5.2	4.2	3.8	3.7	5.8	3.9	4.6
Agriculture	%	7.4	4.3	3.1	1.8	2.0	5.8	2.3	3.7
Industry	%	18.1	8.0	6.0	5.0	4.9	13.0	5.3	8.3
Commercial	%	9.3	7.0	5.3	4.8	4.5	8.1	4.8	6.1
Government	%	5.2	4.6	3.8	3.9	3.9	4.9	3.9	4.3
Street light	%	8.4	5.0	3.3	2.1	1.3	6.7	2.2	4.0
Residential	%	5.4	3.5	3.1	2.6	2.6	4.5	2.7	3.4
T/D loss	%	-3.3	5.3	4.3	3.8	3.7	0.9	3.9	2.7

(Source: JICA Study Team)

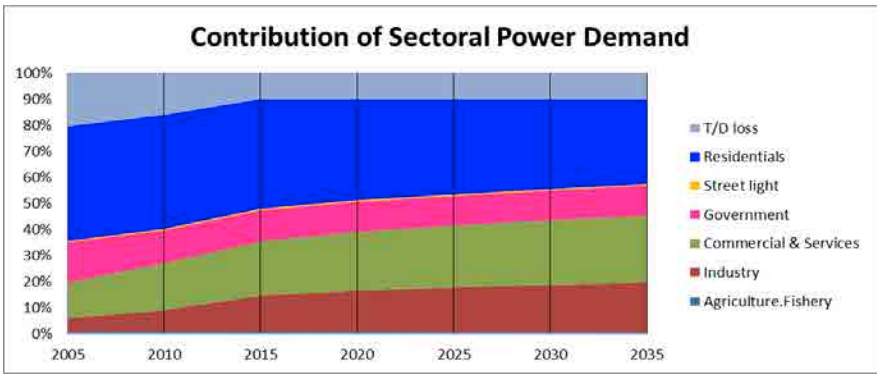


Figure 9- 1 Contribution of Power Demand by Sector (Baseline)

Table 9- 3 Peak Demand Forecasts (Baseline)

Item	Unit	2010	2012	2015	2020	2025	2030	2035
Load factor	%	57.9	58.0	58.0	58.0	58.0	58.0	58.0
Oman peak demand	MW	4,280	4,924	5,758	7,432	9,148	11,008	13,217
MIS peak demand	MW	3,787	4,383	5,124	6,614	8,142	9,797	11,763

Note) Oman Peak demand and MIS peak demand are "Power sending output".
Note) The values in 2010 are actual, and the forecast value are after 2012

(Source: JICA Study Team)

Table 9- 4 Primary Energy Consumption Forecasts (Baseline)

Primary Energy Consumption	Unit	2010	2012	2015	2020	2025	2030	2035
Total	1,000 toe	15,058	16,890	18,636	23,119	26,759	31,680	37,510
Crude oil	1,000 toe	7,928	8,898	9,557	12,054	13,541	16,151	19,019
Natural gas	1,000 toe	7,130	7,987	9,060	11,024	13,153	15,440	18,379
Renewable energy	1,000 toe	0	4	18	41	65	89	112
Biomass	1,000 toe	0	0	0	0	0	0	0

(Source: JICA Study Team)

Table 9- 5 Growth rates of Primary Energy Demand (Baseline)

Growth Rate	Unit	15/10	20/15	25/20	30/25	35/30	20/10	35/20	35/10
Total	%	4.4	4.4	3.0	3.4	3.4	4.4	3.3	3.7
Crude oil	%	3.8	4.8	2.4	3.6	3.3	4.3	3.1	3.6
Natural gas	%	4.9	4.0	3.6	3.3	3.5	4.5	3.5	3.9

(Source: JICA Study Team)

9.2 Methodologies for Estimating Effects of EE&C Measures

9.2.1 Pre-conditions for Targeted Coverage and EE&C Rates by Measure

The EE&C effects of the measures are defined by the targeted coverage and annual EE&C rates of the sectoral measures. EE&C rates are described with two kinds of formulas in the following table. One is defined by the "Accumulated improved rate of the EE&C efficiencies (indicated with a "+" sign in the table)" and another is the "One time improved rate per the EE&C action (indicated without "+" sign)".

For example, the EE&C rate of the Energy Management System (EMS) in the table is shown by the former formula (1 % improvement every year), and the other EE&C measures are shown by the latter formula.

Table 9- 6 Pre-conditions for Estimating Effects of EE&C Measures

Sector	EE&C Measure	Power Coverage in the Sector	EE&C Rate
Industry	Energy Management System (EMS)	90 %	+1 % / year
Commercial	Energy Management System (EMS) Labeling System (MESL) Light EE&C Building Regulation (EBR)	60 % 22 % 40 %	+1 % / year 9 % 25 %
Government	Energy Management System (EMS) Labeling System (MESL)Light EE&C Building Regulation (EBR)	60 % 22 % 40 %	+1 % / year 9 % 25 %
Residential	Labeling System (MESL) AC Labeling System (MESL) Refrigerator Labeling System (MESL) Light EE&C Building Regulation (EBR) AC Smart Meter (SM)	39 % 29 % 12 % 39 % 70~80 %	23 % 15 % 9 % 28 % 2 %~4 %

Note) Washing machine as a MESL product is not considered because its electricity consumption is not so much compared with other MESL products.

As an example for understanding the above table, the EE&C rates in the commercial sector are described as follows;

- In the commercial sector, the EE&C rate of EMS is improved at 1 % per year to 60 % of the power consumption in the commercial sector.
- When the energy saving lights in line with the MESL are introduced into commercial buildings, the intensity of power consumption is improved at 9 % per building. Such kinds of buildings are increased up to 22 % of the power consumption in the commercial sector.
- When insulations in line with the EBR are introduced in commercial buildings, the intensity of the power consumption in the building is improved by 25 %. Such kinds of buildings are increased up to 40 % of the power consumption in the commercial sector.

9.2.2 Scenarios of EE&C

When the EE&C rates of the above table are implemented completely at 100 %, it is defined by “Scenario 1.0” in the Chapter. And Scenario 1.0 is named as the “Reference case” in this analysis. For the simulation of the EE&C effect analysis, if EE&C rates are implemented at only 80 % of the above table, it is defined by “Scenario 0.8”. Adversely, when EE&C rates are implemented at 20 % more than the above table, it is defined by “Scenario 1.2”.

Table 9- 7 Baseline and EE&C Scenarios

Scenario Name	EE&C Pre-condition
Baseline	EE&C measures are not introduced.
Scenario 1.0	EE&C measures are introduced and the impact is 100 % as expected.
Scenario 0.8	EE&C measures are introduced and the impact meets 80 % of the expectations.
Scenario 1.2	EE&C measures are introduced and the impact exceeds expectations. (120 %)

Note) Scenario 1.0 is defined as Reference case in the analysis.

9.3 Estimation of EE&C Effects per Scenario

9.3.1 Effects to the Power Demand

(1) EE&C Effects per Scenario

The power demand forecasts at the power sending output after introducing EE&C measures are as follows;

- Power demand including agriculture, industry, commercial entities, government institutions (including street light), residential sectors and T/D loss is 22 TWh in Oman.
- Power demand of Reference case (defined by Scenario 1.0) in 2035 is 44 TWh (Baseline 60 TWh). The reference case is 26 % lower than the Baseline. The reduction of power consumption is an effect of the EE&C measures.
- The power demand of Scenario 0.8（EE&C rate is 20% less than the Reference case）will be 47 TWh in 2035, and it is 21 % less than the Baseline. It means the power demand in Scenario 0.8 is larger than the Reference case due to lower EE&C rates.
- The power demand of Scenario 1.2（EE&C rate is 20 % larger than Reference case）will be 41 TWh in 2035. The power consumption is 31 % less than the Baseline. This is a scenario where the impact exceeds the expectations of the Omani EE&C plan with power consumption reduction exceeding 30 % below the Baseline.

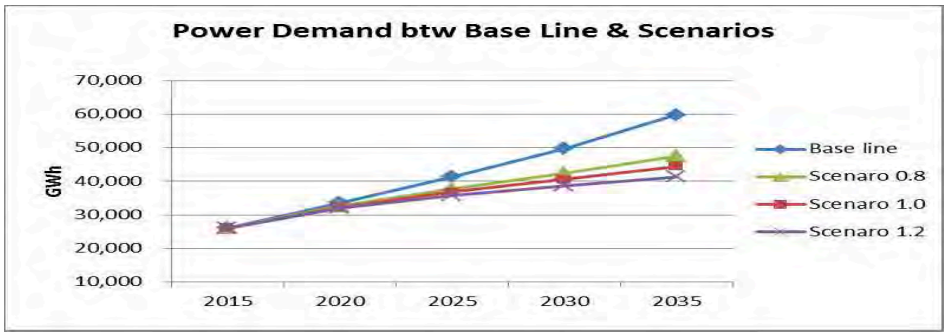


Figure 9- 2 Power Demand by Scenario

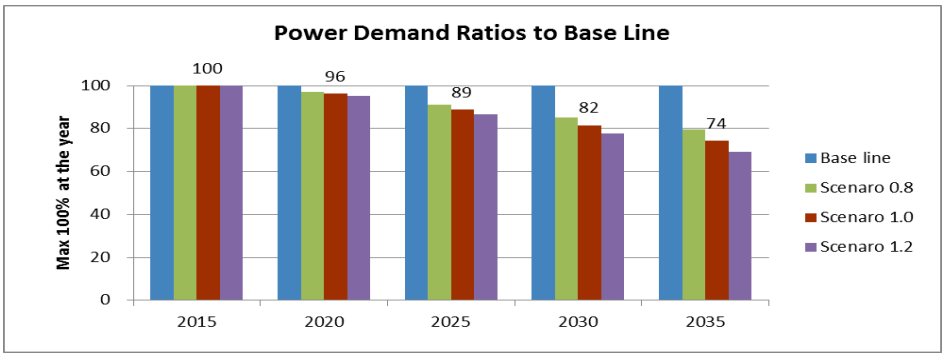


Figure 9- 3 EE&C Effects by Scenario Comparing to the Baseline

(2) Power Saving Effects

Next, the following figure shows the impact of each EE&C measure

- In Reference case (Scenario1.0), the contribution of the power reduction in 2035 per each measure is as shown in the following figure. The power saving in the Reference case in 2035 to the Baseline is 15 TWh, and the contributions of the measures from Minimum Energy Standards and Labeling System (MESL) 48 %, Energy Management System (EMS) 33%, EE&C Building Regulation (EBR) 16 % and Smart Meter (SM) 4%.

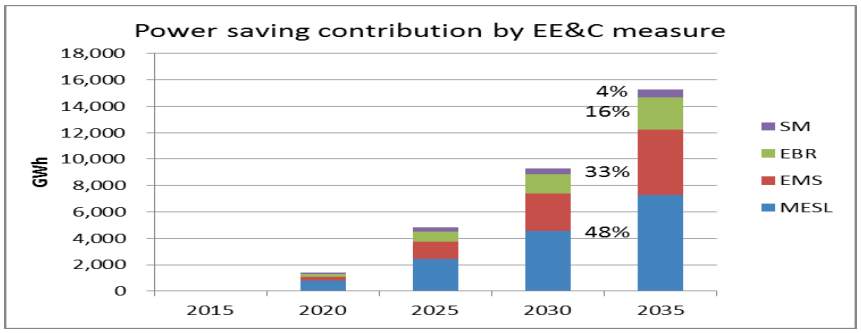


Figure 9- 4 Power Saving Contribution by EE&C Measure

9.3.2 Impact to Peak Demand per Measure

(1) EE&C Effects of Peak Demand per Scenario

(a) Peak Demand in the Whole Country

The effects of nationwide peak demand reduction per the measure are shown in the following table.

- AER publishes the data on “Omani peak demand” and “MIS peak demand” in their annual report. .The Omani peak demand means the total peak demand nationwide at the power sending output in Oman, otherwise, MIS peak demand is the contract peak demand between OPWP and power generation companies. Omani peak demand in 2012 was 5,000 MW.
- Omani peak demand in the Reference case（Scenario1.0）can be forecasted with 7,400

MW (Baseline is 7,800 MW) in 2020. Therefore, Omani peak demand in the Reference case is 5 % less than the Baseline in 2020. While the nationwide peak demand in the Reference case will be 8,800 MW (Baseline is 13,700 MW) in 2035. Omani peak demand in the Reference case is 36% less than the Baseline. It shows the impact of EE&C measures started from 2018.

Table 9- 8 Omani Peak Demands of the Scenarios (Unit: MW)

Scenario	2010	2011	2012	2015	2020	2025	2030	2035
Baseline	4,300	4,800	5,000	6,100	7,800	9,600	11,500	13,700
Scenario 0.8	4,300	4,800	5,000	6,100	7,500	8,300	8,900	9,700
Scenario 1.0	4,300	4,800	5,000	6,100	7,400	8,000	8,400	8,800
Scenario 1.2	4,300	4,800	5,000	6,100	7,300	7,700	7,900	8,100

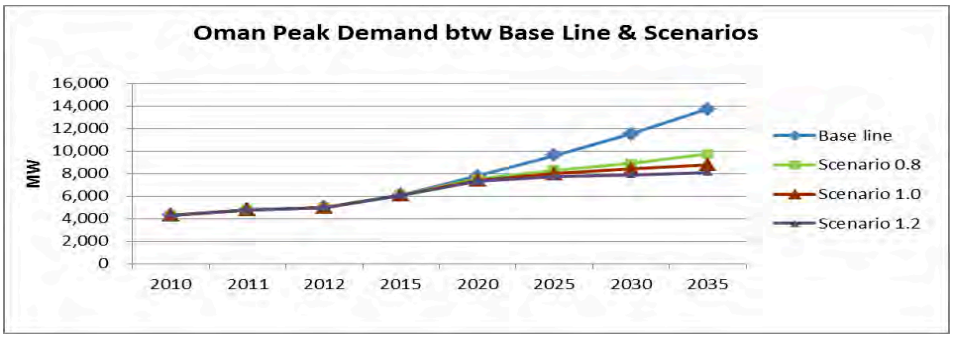


Figure 9- 5 Gross Peak Demands between Baseline & Scenarios

(b) MIS Peak Demand

The effects of MIS peak demand reduction per the measure are shown in the following table.

- The MIS peak demand contracted by OPWP is around 13 % less than the gross peak demand. The MIS peak demand in 2020 will be 6,600 MW in the Reference case (Scenario 1.0).

  The difference between the Reference case and the Baseline will be 400 MW in 2020. While it reaches 7,900 MW in 2035 in the Reference case and the difference to the Baseline will be 4,300 MW in 2035.

Table 9- 9 MIS Peak Demand by Scenario (Unit: MW)

Scenario	2010	2011	2012	2015	2020	2025	2030	2035
Baseline	3,800	4,300	4,400	5,400	7,000	8,500	10,200	12,200
Scenario 0.8	3,800	4,300	4,400	5,400	6,700	7,400	8,000	8,600
Scenario 1.0	3,800	4,300	4,400	5,400	6,600	7,100	7,500	7,900
Scenario 1.2	3,800	4,300	4,400	5,400	6,500	6,800	7,100	7,200

（Source: Actual Values by 2011, JICA Study Team's forecast values after 2012）

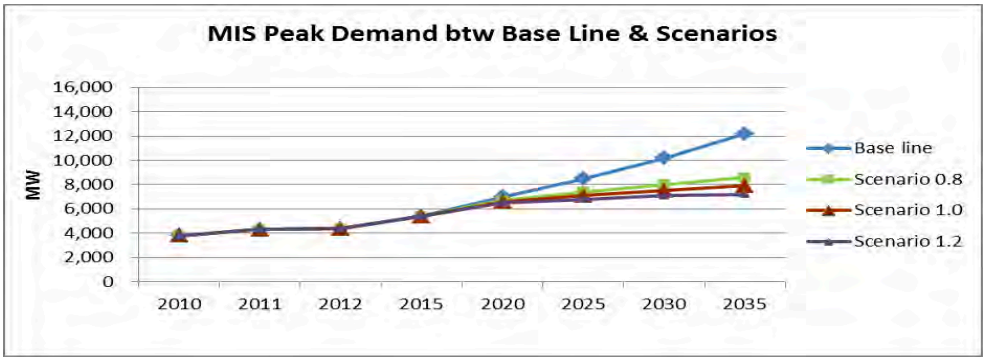


Figure 9- 6 MIS Peak Demand between Baseline & Scenarios

(2) Effects of Nationwide Peak Demand Reduction

The effects of nationwide peak demand reduction per measure is shown in the following table.

- When looking at the peak shift and peak cut in the Reference case（Scenario 1.0）in 2035, the effects of the contributions of the EE&C measure are as shown in the following figure. The peak reduction in 2035 will be 4,700 MW. The respective contribution from Minimum Energy Standards and Labeling System (MESL) is 50 %, Energy Management System (EMS) is 25 %, EE&C Building Regulation (EBR) is 19 % and the DSM Tariff System (DTS) is 6 %.

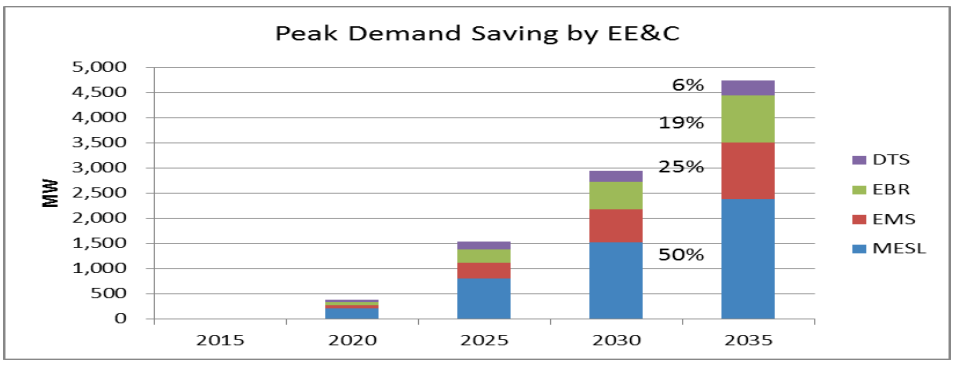


Figure 9- 7 Peak Demand Saving Contribution by EE&C Measure in Reference Case

9.3.3 Impact to Primary Energy Consumption

(1) Effects by Measures

(a) Effects of Natural Gas Consumption Reduction

The effects of natural gas demand reduction per scenario is shown in the following figure.

- The primary energy resources in Oman are natural gas, crude oil, renewable energies and bio mass energy. Natural gas is used for the power source in the power sector and fuel and raw feedstock in the industry sector. Most of the domestic consumption of natural gas is used in the power sector.

- When looking at the EE&C effects on primary energy consumption in the Baseline, the domestic consumption of natural gas in 2012 was 7.9 million toe (316 trillion Btu) and will reach 18.4 million (736 trillion Btu) in 2035. On the other hand, in the Reference case (Scenario 1.0), it will become 14.2 million toe (568 trillion Btu) in 2035. The natural gas saving rate between the two is 23 %.

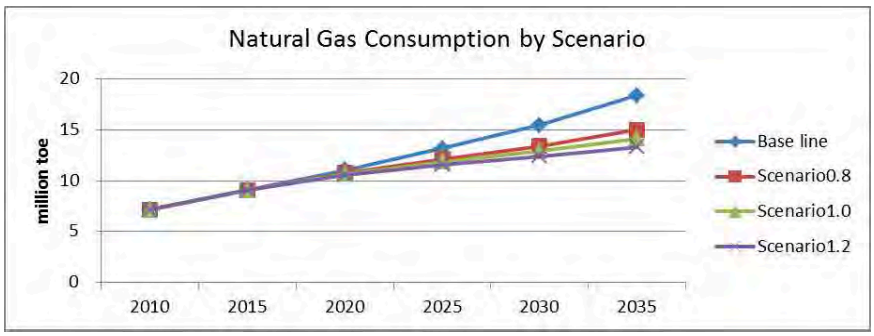


Figure 9- 8 Natural Gas Domestic Consumption by Scenario

(b) EE&C Effects for Primary Energy Consumption Reduction

The total primary energy consumption reduction per measure is shown in the following figure.

- Primary energy consumption including oil products and natural gas was 17 million toe in 2012. It will reach 38 million toe in the Baseline and 33 million toe in the Reference case (Scenario 1.0) in 2035. The primary energy consumption saving rate between the two is 13 % in 2035.
- Most of the oil products in Oman are used for the transportation sector, the oil products consumption is set with the same values in the Baseline, Scenario 1.0, Scenario 0.8 and Scenario 1.2 due to the fact that the transportation sector is out of the Study Team's scope. Therefore, the oil product's consumption saving in the Reference case (Scenario 1.0) depends on fuel consumption reduction in the industry sector by the Energy Management System (EMS).

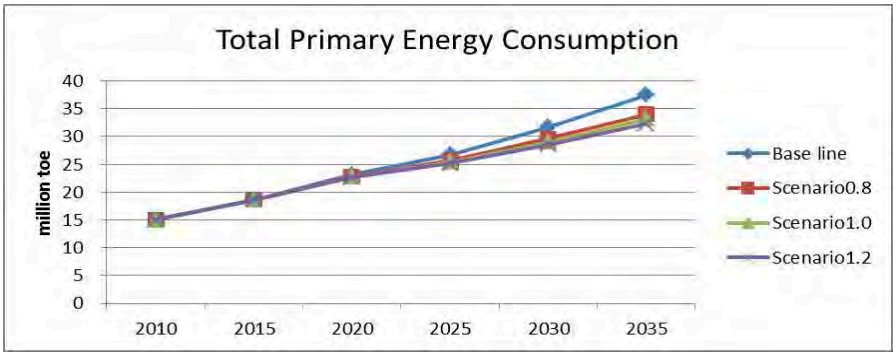


Figure 9- 9 Total Primary Energy Consumption by Measure

9.4 Effect Analysis by EE&C Measure

9.4.1 Energy Saving Analysis of EE&C Effects

The following table shows the EE&C measures and its energy saving effects. As energy saving effects, there are power consumption reductions, peak shifts (or cuts) and fuel consumption reductions (natural gas and oil products) in the industrial sector.

Power consumption reductions, peak shifts (or cuts) and fuel consumption reductions through the Energy Management System (EMS), Minimum Standards and Labeling System (MESL), EE&C Building Regulation (EBR), DSM Tariff Systems (DTS) and Smart Meters (SM) are shown in the following table. The effects are shown by the difference between the Baseline and the Reference case (Scenario 1.0).

Table 9- 10 Energy-Saving Effects per EE&C Measure

Items	Measures	Unit	2015	2020	2025	2030	2035
Power Saves	EMS	GWh	0	288	1,304	2,811	4,974
	MESL	GWh	0	784	2,454	4,575	7,264
	EBR	GWh	0	231	755	1,479	2,456
	SM	GWh	0	101	303	430	597
	Total	GWh	0	1,404	4,816	9,295	15,291
Peak Demand Saves	EMS	MW	0	60	312	659	1,132
	MESL	MW	0	216	806	1,521	2,379
	EBR	MW	0	66	267	550	934
	DTS	MW		46	157	219	291
	SM	MW	0	21	73	101	136
	Total	MW	0	409	1,615	3,050	4,872
Primary Energy Saves	EMS(NG)	ktoe	0	670	3,033	6,540	11,574
	EMS(Oil)	ktoe	0	10	60	120	230
	MESL(NG)	ktoe	0	1,825	5,711	10,646	16,903
	EBR(NG)	ktoe	0	537	1,757	3,440	5,714
	SM(NG)	ktoe	0	234	705	1,002	1,389
	Total	ktoe	0	3,277	11,266	21,748	35,810

Note) Primary energy consumption reductions in the table are calculated by Natural gas equivalent to power saving. The natural gas is divided by generation efficiency (33 %).

9.4.2 Monetary Benefits of EE&C Effects

(1) Pre-conditions for Converting the Effects into Monetary Benefits

The EE&C effects shown by the US$ and RO as monetary benefits are calculated by using the international natural gas price (National Balancing Point Index published by BP statistics), international crude oil price (Dubai crude oil price published by BP statistics) and the investment cost of the gas combined cycle with 1,000 US$/kW for the power generation unit

cost.

Table 9- 11 Unit Prices for Calculating Monetary Benefits

Items	Used data	Unit	2015	2020	2025	2030	2035
Unit cost for power plant	1,000 US$/kW Depreciation: 16 years	US$/kW/year	62.5	62.5	62.5	62.5	62.5
International Natural gas price	NBP index	US$/MMBtu	6.1	6.4	6.7	6.9	7.1
International Crude oil price	Dubai crude oil price	US$/bbl	112	124	133	143	153

Note) The values in the table are at 2012 constant price.

(2) Results of Monetary Benefits

The following table shows the monetary benefits of natural gas and oil saved and the peak reduction shown by the US dollar and RO. Per the EE&C measures, the benefits reach 119 million US$ (48 million RO) in 2020 and 1,631 million US$ (652 million RO) in 2035 between the Baseline and the Reference case (Scenario 1.0). The contents of the benefits are the amount of natural gas and crude oil saved and the investment reduction for the power generators.

Table 9- 12 EE&C Effects in US$ by Measure (in US$)

Effects	Unit	2015	2020	2025	2030	2035
EMS	million US$	0	30	158	346	660
MESL	million US$	0	61	208	404	664
EBR	million US$	0	18	65	135	234
DTS	million US$	0	3	11	16	22
SM	million US$	0	7	24	35	50
Total effects of the above	million US$	0	119	465	936	1,631

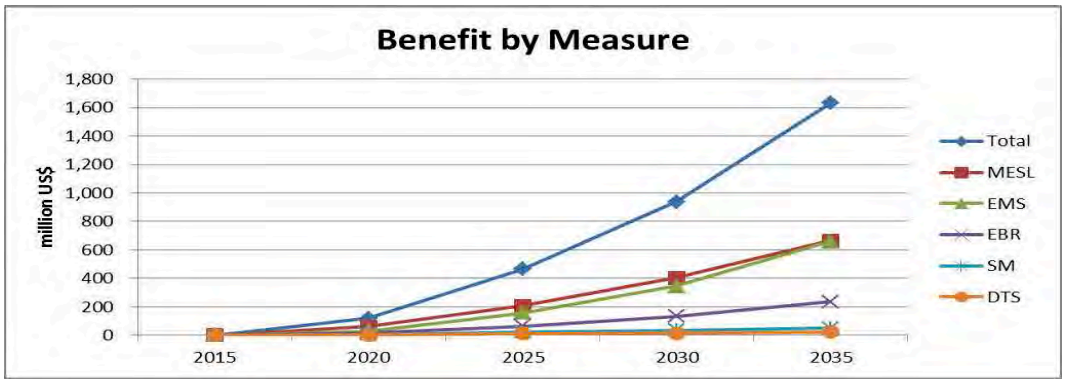


Figure 9- 10 EE&C Monetary Benefit Trends by Measure (in US$)

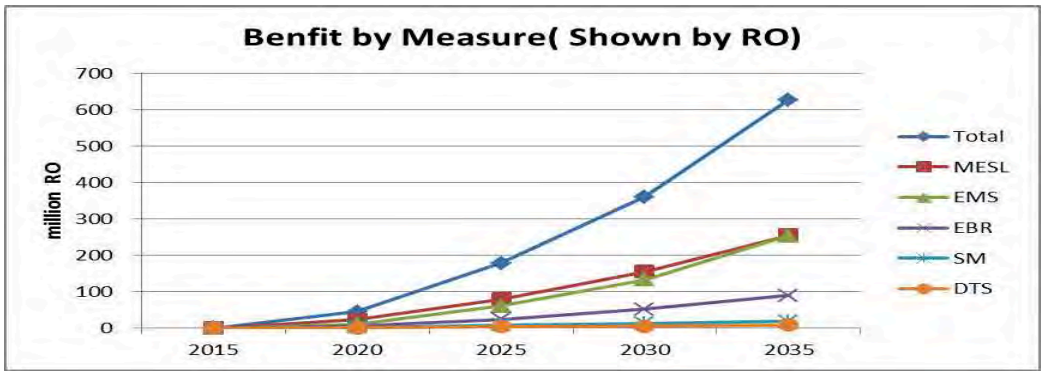


Figure 9- 11 EE&C Monetary Benefit Trends by Measure (in RO)

9.5 Summary of EE&C Effect Analysis

The followings are the summary of the effects of EE&C measures and a scenario analysis.

- **Power Demand Forecasts after Introducing EE&C Measures**
  The total power demand including agriculture, industry, commercial, government (including the street light), residential sectors and T/D losses in Oman was 22 TWh in 2012. According to the Study team forecasts, it will increase up to 60 TWh up to 2035. The power demand in 2035 is 44 TWh in the Reference case (Scenario 1.0), and it is 26 % less than the Baseline. In the same year, the power demands are 47 TWh in Scenario 0,8 and 41 TWh in Scenario 1.2. Therefore, the power saving rates are 21 % less and 31 % less than the Baseline respectively. As the summary, the power demand after introducing EE&C measures in Oman is from 20 % to 30 % (42 TWh to 48 TWh as the power demand), less than Baseline up to 2035.

- **Peak Demand after Introducing EE&C Measures**
  The country wide peak demand without any EE&C measures (Baseline) will be 14GW in 2035. The peak demand after introducing EE&C measures from 10 GW to 11 GW in 2035. Therefore, it means to be able to reduce the peak demand from 3 GW to 4 GW up to 2035.

- **Energy Saving Contribution per EE&C Measure**
  The JICA Study Team proposes the Energy Management System (EMS), Minimum Energy Standards and Labeling System (MESL), EE&C Building Regulation (EBR), DSM tariff System (DTS) and Smart Meter (SM) as the EE&C measure for future Oman. The power saved will be 16 TWh in 2035, and when looking at the power saving contributions due to the EE&C measure in 2035, the MESL is 48 %, the EMS is 33 %, the EBR is 16 % and the SM is 4 %.
  As the EBR is promoted in line with the building and/or rebuilding of the houses and the commercial and government use buildings, it is considered that compared with other

EE&C measures, the manifestations of the EBR effects is slower. Therefore, it can be mentioned that the effect of EBR will not manifest themselves completely up to the year of 2035. As a recommendation, the effects of EBR should be considered to take a longer term period than this analysis.

- **EE&C Monetary Benefits by Measure**

  As the EE&C benefits, there are power consumption reductions (natural gas consumption reduction as power sources) in all sectors, fuel consumption reduction in the industry sector and investment reductions for new power generators. When looking at the benefits from the perspective of the EE&C measures proposed by the JICA Study Team, the MESL is 660 million US$, the EMS is 660 million US$, the EBR is 230 million US$, the DTS is 20 million US$ and the SM is 50 million US$. The total monetary benefit is 1,620 million US$.

Chapter 10 Cost Benefit Analysis

10.1 Methodology for Estimating Additional Investments for EE&C Measures

The study of the cost and benefit analysis for EE&C measures is examined in this chapter. It can be considered that additional investments as well as the governmental costs (Administration costs) for implementing EE&C measures described in Chapter 8 are required. The following three EE&C measures require additional investments for implementing the EE&C measures in the 6 measures proposed by the Study team.

- Energy Management System (EMS)
- Minimum Energy Standards and Labeling System (MESL)
- EE&C Building Regulation(EBR)

Although the implementations of the DSM Tariff System (DTS) and Smart Meter (SM) require some kinds of meters and communication systems, however, additional investments are not included in the study under the conditions that the above infrastructure will be prepared in the difference from the implementation of EE&C measures. Furthermore, the EE&C Dissemination Program (EDP) is operating under the assumption that there will not be any investments. The calculations of the said additional investments for EE&C measures are as follows;

- Energy Management System (EMS): The sectoral investments for the industrial, commercial and government sectors are forecasted by using the sectoral GDP growth rates. After that, the EE&C investments for the measures are calculated by the sectoral investments.
- Labeling System (MESL): The additional investment for MESL is calculated by the social stocks in line with the related factors and the future trends.
- Building Regulation (EBR): The methodology is the same as MESL.

10.2 Estimation of the Additional Investment for EE&C Measures

10.2.1 Energy Management System

(1) Sectoral GDP Outlooks

As shown in the following table, the average GDP growth rate of 4%～5% over the next ten years is forecasted, and the growth rates of the industry, power & water and construction sectors are higher than others.

Table 10- 1 GDP Outlook by Sector

Sector	Unit	2013	2014	2015	2020	2025	2030	2035
GDP Growth Rate	%/year	5.0	5.0	5.0	5.0	3.6	3.7	4.0
Oil / Gas & Others	%/year	2.3	2.2	2.5	2.5	1.8	1.9	2.0
Industry	%/year	7.7	7.7	7.6	7.3	5.8	5.6	5.4
Power & Water	%/year	7.7	7.7	5.5	5.0	3.6	3.7	4.0
Commercial & Services	%/year	5.5	5.5	5.5	5.5	4.8	4.5	4.3
Government & Publics	%/year	5.5	5.5	5.5	5.5	4.8	4.5	4.3
Transportation	%/year	5.5	5.5	5.5	5.5	4.8	4.5	4.3
Construction	%/year	7.7	7.7	7.6	7.3	5.8	5.6	5.4

(2) Estimation of Sectoral Investments

The following table is the sectoral investments estimated by the above sectoral GDP growth rates. The growth rates of the sectoral investments in the following table are set by the same growth rates of the sectoral GDP. It is a reason that the total investment to the total GDP in current Oman has already had a big share comprising 35% of the GDP.

Table 10- 2 Estimation of Sectoral Investments Unit: million US$

Sector	2012	2013	2014	2015	2020	2025	2030	2035
Oil Gas & Agriculture	8,303	8,676	8,840	9,117	10,648	11,586	12,659	13,984
Industry Sector	1,756	1,891	2,036	2,190	3,129	4,179	5,502	7,168
Power & Water Sector	348	367	387	408	527	642	781	951
Commercial & Services	4,052	4,275	4,509	4,757	6,226	7,868	9,866	12,245
Government & Publics	2,913	3,073	3,242	3,420	4,476	5,656	7,093	8,803
Transportation	1,643	1,733	1,829	1,929	2,525	3,191	4,001	4,965
Construction	1,791	1,929	2,077	2,235	3,192	4,264	5,613	7,313
Total	20,806	21,944	22,919	24,057	30,722	37,386	45,514	55,429

(3) Estimation of Additional Investments

EMS is one of the EE&C measures for the industrial, commercial and government sectors. The additional investments in EMS in the sectors are estimated by the factors of sectoral coverage ratios to the sectoral total sites, EMS implementation site ratio to the covered sites and the additional investment ratio to the EE&C implemented sites. The additional investment ratio is set at 10 % (after referring to Japanese experience).

Table 10- 3 Additional Investments for EMS

Sector	Item	Parameter	2018	2019	2020	2025	2030	2035
Industry	Sector investment	Mil US$	3198	3419	3656	4821	6283	8120
	Coverage	0.90		90.0%	90.0%	90.0%	90.0%	90.0%
	Investor shares	0.10		10.0%	10.0%	10.0%	10.0%	10.0%
	EMS investment rate	0.10		10.0%	10.0%	10.0%	10.0%	10.0%
	EMS investment			30.8	32.9	43.4	56.5	73.1
Commercial	Sector investment	Mil US$	5,589	5,899	6,226	7,868	9,866	12,245
	Coverage	0.60		60.0%	60.0%	60.0%	60.0%	60.0%
	Investor shares	0.10		10.0%	10.0%	10.0%	10.0%	10.0%
	EMS investment rate	0.10		10.0%	10.0%	10.0%	10.0%	10.0%
	EMS investment			35.4	37.4	47.2	59.2	73.5
Government	Sector investment	Mil US$	4,018	4,240	4,476	5,656	7,093	8,803
	Coverage	0.60		60.0%	60.0%	60.0%	60.0%	60.0%
	Investor shares	0.10		10.0%	10.0%	10.0%	10.0%	10.0%
	EMS investment rate	0.10		10.0%	10.0%	10.0%	10.0%	10.0%
	EMS investment			25.4	26.9	33.9	42.6	52.8
Total	EMS investment total	mil US$		91.6	97.1	124.5	158.3	199.4

10.2.2 Minimum Energy Standards and Labeling System (MESL)

(1) Targeted Appliances on Additional Investments of MESL

Regarding the study for additional investment of MESL, only air conditioners (AC) and refrigerators are targeted. Lighting appliances are outside the target because it is difficult to grasp the number in stock and the costs are not so large when it comes to implementing MESL. Furthermore, washing machines are also not targeted due to the fact that they do not consume so much power among home electric appliances.

(2) Additional Investments for MESL

The following table shows the results of the additional investments for MESL.

Table 10- 4 Estimation of Additional Investments for MESL

Item	Unit	2018	2019	2020	2025	2030	2035
Number of houses	1,000 unit	469	478	488	539	582	628
AC / house	set / unit	7	7	7	7	7	7
AC No. for new house	1,000 set	64	65	66	75	62	67
AC No. for exist house	1,000 set	288	288	288	288	288	288
AC No. for total house	1,000 set	351	353	354	363	349	354
Invest for AC	1,000 RO	21,083	21,160	21,238	21,791	20,955	21,257
Invest for AC	million US$	54.8	55.0	55.2	56.6	54.4	55.2
Refrigerator / house	set / unit	2	2	2	2	2	2
Ref. No. for new house	1,000 set	127	130	133	151	123	133
Ref. No. for exist house	1,000 set	82	82	82	82	82	82
Ref. No. for total house	1,000 set	210	212	215	233	205	215
Invest for Refrigerator	1,000 RO	12,574	12,728	12,884	13,989	12,318	12,923
Invest for Refrigerator	million US$	32.7	33.1	33.5	36.3	32.0	33.6
MESL invest for houses	million US$	87.4	88.0	88.6	92.9	86.4	88.8

Note: Due to the rounding, the total amount may not match with the sum of each component.

10.2.3 EE&C Building Regulation (EBR)

(1) Targeted Building on Additional EBR Investments

Regarding the study for additional EBR investments, residential houses, commercial and government use buildings are targeted. There are two kinds of houses and buildings such as the existing house & building and new houses & buildings for additional investments. In the study, some parts of the existing houses & buildings and all of the new houses and buildings are targeted.

(2) Estimation of Additional Investments

The following table is the additional investments for EBR.

Table 10- 5 Additional Investments for EBR

Sectors	Items	Unit	2018	2019	2020	2025	2030	2035
Residential	Existing houses	unit	411,000	411,000	411,000	411,000	411,000	411,000
	New houses	unit	9,098	9,281	9,467	10,782	8,792	9,513
	Reformed houses	unit	13,686	13,686	13,686	13,686	13,686	13,686
	EBR houses	unit	5,240	5,282	5,325	5,628	5,170	5,336
	Invest for EBR	1,000 RO	7,337	7,395	7,455	7,879	7,238	7,470
	Invest for EBR	million US$	19.1	19.2	19.4	20.5	18.8	19.4
Commercial	Existing Buildings	unit	16,430	16,430	16,430	16,430	16,430	16,430
	New buildings	unit	2,318	2,689	3,067	5,126	6,829	8,672
	Reform buildings	unit	547	547	547	547	547	547
	EBR buildings	unit	2,865	3,236	3,614	5,673	7,376	9,219
	Invest for EBR	1,000 RO	10,600	11,972	13,373	20,990	27,293	34,112
	Invest for EBR	million US$	27.5	31.1	34.7	54.5	70.9	88.6
Government	Existing Buildings	unit	2,175	2,175	2,175	2,175	2,175	2,175
	New buildings	unit	307	356	406	678	904	1,148
	Reform buildings	unit	72	72	72	72	72	72
	EBR buildings	unit	379	428	478	751	976	1,220
	Invest for EBR	1,000 RO	1,100	1,242	1,387	2,178	2,831	3,539
	Invest for EBR	million US$	2.9	3.2	3.6	5.7	7.4	9.2
Total invest		million US$	49.4	53.5	57.7	80.6	97.0	117.2

Note: Due to the rounding, the total amount may not match with the sum of each component.

10.3 Cost & Benefit Analysis

10.3.1 Cost and Benefit of all EE&C measures

(1) Total Costs for the Measures

The total costs for all the measures consist of the government costs to implement EE&C measures and the additional investments for all EE&C measures. The following table is the results summing up the governmental costs mentioned in Chapter 8 and the additional investments described in the above sessions.

Table 10- 6 Total Costs for All EE&C Measures Unit: million US$

Measures		2013	2014	2015	2016	2017	2018	2019	2020	2025	2030	2035
Total	Investment	0.0	0.0	0.0	0.0	0.0	136.9	233.1	243.4	298.2	341.8	405.3
	Admi. cost	1.8	2.2	1.9	8.8	6.4	20.2	20.1	6.5	5.8	5.8	5.8
	Total	1.8	2.2	1.9	8.8	6.4	157.2	253.3	249.9	304.0	347.6	411.1
EMS	Investment	0.0	0.0	0.0	0.0	0.0	0.0	91.6	97.1	124.5	158.3	199.4
	Admi. cost	0.5	0.5	0.8	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8
	Subtotal	0.5	0.5	0.8	0.9	0.8	0.8	92.4	97.9	125.3	159.1	200.1
MESL	Investment	0.0	0.0	0.0	0.0	0.0	87.4	88.0	88.6	92.9	86.4	88.8
	Admi. cost	0.1	0.5	0.3	1.5	1.5	14.2	14.2	0.6	0.6	0.6	0.6
	Subtotal	0.1	0.5	0.3	1.5	1.5	101.6	102.2	89.2	93.5	87.0	89.4
EBR	Investment	0.0	0.0	0.0	0.0	0.0	49.5	53.5	57.7	80.7	97.1	117.2
	Admi. cost	0.4	0.4	0.5	0.3	0.3	1.3	1.3	1.3	1.0	1.0	1.0
	Subtotal	0.4	0.4	0.5	0.3	0.3	50.8	54.8	59.0	81.7	98.1	118.2
DTS	Investment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Admi. cost	0.4	0.4	0.2	0.0	0.4	0.4	0.4	0.4	0.0	0.0	0.0
	Subtotal	0.4	0.4	0.2	0.0	0.4	0.4	0.4	0.4	0.0	0.0	0.0
SM	Investment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Admi. cost	0.3	0.3	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
	Subtotal	0.3	0.3	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
EDP	Investment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Admi. cost	0.1	0.2	0.1	6.0	3.4	3.4	3.4	3.4	3.4	3.4	3.4
	Subtotal	0.1	0.2	0.1	6.0	3.4	3.4	3.4	3.4	3.4	3.4	3.4

Note 1: 1 US$=0.385 RO

Note 2: Due to the rounding, the total amount may not match with the sum of each component.

(2) Cost and Benefit Analysis for All EE&C Measures

The net benefit is calculated by the expression to subtract the above total costs from the monetary benefits mentioned in Chapter 9.

As for the results, the Internal Rate of Return (IRR) for all measures is 25 %, and the Cost & Benefit ratio (B/C ratio) is 2.1 times (2013～2035).

Table 10- 7 Cost and Benefit Analysis for All EE&C Measures

Items	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2025	2030	2035
Benefit	million US$	0	0	1	4	5	24	64	118	464	935	1,630
Investment cost	million US$	0	0	0	0	0	137	233	243	298	342	405
Admi cost	million US$	1.8	2.2	1.9	8.8	6.4	20.2	20.1	6.5	5.8	5.8	5.8
Balance	million US$	-2	-2	-1	-5	-2	-133	-189	-132	160	588	1,219
IRR	%	25%		B/C	2.1	times						

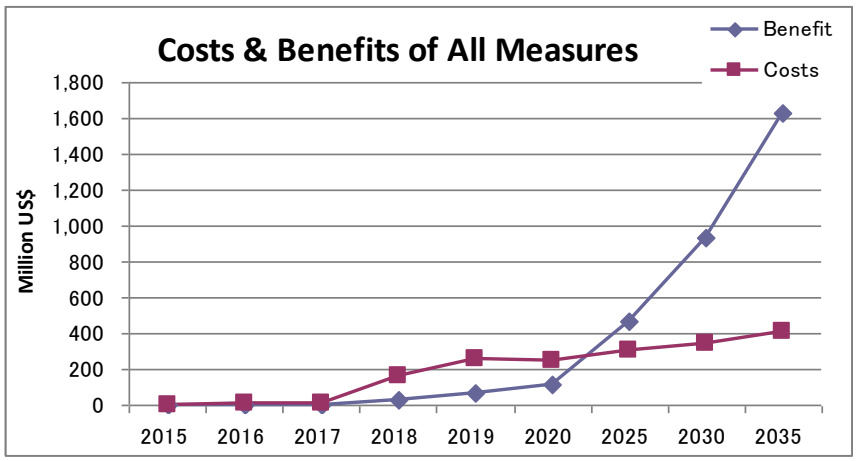


Figure 10- 1 Cost and Benefit towards 2035

10.3.2 Cost and Benefit Analysis by Measure

(1) Energy Management System (EMS)

The cost and benefit analysis of EMS is studied in the following table. As for the results, the Internal Rate of Return (IRR) of the EMS measure is 22 %, and the Cost & Benefit ratio (B/C ratio) is 1.9 times (2013～2035).

Table 10- 8 Cost and Benefit Analysis for EMS

	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2025	2030	2035
Benefit	million US$							9.7	29.7	157.5	346.5	659.9
Investment cost	million US$							91.6	97.1	124.5	158.3	199.4
Admi cost	million US$	0.51	0.51	0.77	0.90	0.76	0.76	0.78	0.78	0.8	0.8	0.8
Balance	million US$	-0.51	-0.51	-0.77	-0.90	-0.76	-0.76	-82.73	-68.15	32.2	187.4	459.8
IRR		22%		B/C	1.9	times						

(2) Labeling System (MESL)

Cost and benefit analysis of MESL is studied in the following table. As for the results, the Internal Rate of Return (IRR) of the MESL measure is 32 %, and the Cost & Benefit ratio (B/C ratio) is 3.2 times (2013～2035).

Table 10- 9 Cost and Benefit Analysis for MESL

Items	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2025	2030	2035
Benefit	million US$						15.8	37.3	61.1	207.8	404.1	664.4
Investment cost	million US$						87.4	88.0	88.6	92.9	86.4	88.8
Admi cost	million US$	0.1	0.5	0.3	1.5	1.5	14.2	14.2	0.6	0.6	0.6	0.6
Balance	million US$	-0.1	-0.5	-0.3	-1.5	-1.5	-85.9	-64.9	-28.1	114.3	317.1	575.0
IRR		32%		B/C	3.2	times						

(3) EE&C Building Regulation (EBR)

The cost and benefit analysis of EBR is studied in the following table. As for the results, the Internal Rate of Return (IRR) of the EBR measure is 5 %, and the Cost & Benefit ratio (B/C ratio) is 1.1 times (2013～2035).

The IRR of EBR is lower than other EE&C measures, because the manifestation of the benefits of EBR is slower than other EE&C measures. The benefits of EBR are extended in line at the same speed as the replacement or reconstruction of houses and buildings. In the study, the economic evaluation period of IRR is calculated up to 2035, so the benefits of EBR are not completely included. As the result, the IRR of EBR is lower than other EE&C measures.

Table 10- 10 Cost and Benefit Analysis for EBR

		2013	2014	2015	2016	2017	2018	2019	2020	2025	2030	2035
Benefit	million US$						4.5	10.9	18.2	65.2	134.8	234.5
Investment cost	million US$						49.5	53.5	57.7	80.7	97.1	117.2
Admi cost	million US$	0.38	0.38	0.47	0.33	0.33	1.34	1.34	1.34	1.05	1.05	1.05
Balance	million US$	-0.38	-0.38	-0.47	-0.33	-0.33	-46.3	-43.9	-40.9	-16.5	36.7	116.2
IRR		5%		B/C	1.1	times						

10.4 CO_2 Emission Reduction Effects

The following table shows the effects of global warming CO2 emissions reductions after implementing EE&C measures. The emissions are shown by energy origin CO2 and the nationwide global warming CO2 emissions including all kinds of emission sources (Ex. emissions from animals). EE&C measures contribute to the reduction of CO2 emitted from energy sources.

CO2 emission from energy sources in Oman was 32 million tons of CO2 in 2010. The emissions in 2035 reached 80 million tons of CO2 in the Baseline and 70 million tons of CO2 in the Reference case (Scenario 1.0). The emissions reduction rate between the Baseline and the Reference case will be 12.5 % in 2035.

Regarding the CO2 emissions of the whole country, it was 43 million tons CO2 in 2010, the emissions were 107 million tons of- CO2 in the Baseline and 94 million tons of CO2 in the Reference case.

Table 10- 11 Effects of CO_2 Emission Reduction (Unit : CO_2 million ton)

Items	Sectors	2010	2015	2020	2025	2030	2035	20/10	35/20	35/10
Baseline	Energy Origin	32	40	49	58	68	80	4.4%	3.2%	3.7%
	Whole Country	43	54	66	78	91	107	4.4%	3.2%	3.7%
Reference Case	Energy Origin	32	40	49	55	62	70	4.2%	2.4%	3.1%
	Whole Country	43	54	65	74	83	94	4.2%	2.4%	3.1%
Difference	Energy Origin	0	0	1	3	6	10			
	Whole Country	0	0	1	4	8	13			

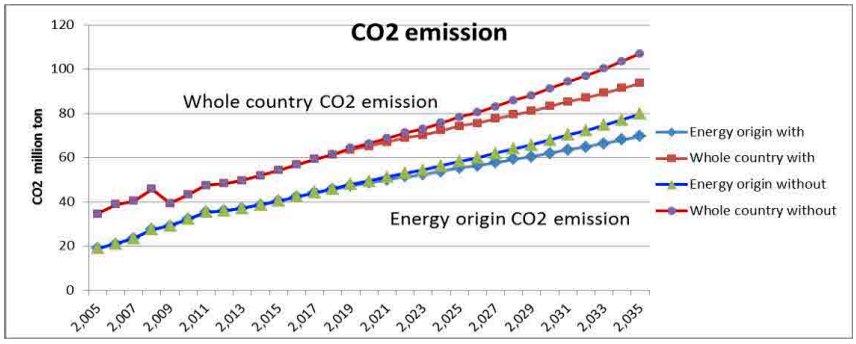


Figure 10- 2 CO_2 Emission from the Energy Origin and the Whole Country (Baseline and Reference Case)

10.5 Effects of Employment Opportunity Creation

10.5.1 Employment Opportunities in Promoting EE&C

It is expected that the two EE&C measures such as EMS and EBR directly contribute to the creation of employment opportunities due to the structural requirements for promoting the measures. Especially, the two measures will create job opportunities in the private sector. The

employment opportunity is as shown in the following table.

Table 10- 12 Employment Opportunity for Private Sector by EE&C

	Employment Opportunity for Private Sector.	Persons	Total Number
EMS	Energy auditor	25	75
	Energy manager (Outsourcing)	40	
EBR	Design consultant	10	

10.5.2 Job Creation Effect for Employment

Generally, incremental investments create employment opportunities in the country. When the monetary net benefits of EMS and EBR are re-invested in the country, the investment amount will reach 421 million US$. The number of employees created by the investment reaches 27,000 persons in 2035 as shown in the following table.

Table 10- 13 Employment Opportunity Creation by EMS & EBR

	Net benefit	Added value	Multi effects	Income / person	Employee
	million US$	%	million US$	1000 US$	persons
2018	-47.3	50	0	17.7	0
2019	-130.2	50	0	18.0	0
2020	-116.8	50	0	18.4	0
2021	-101.4	50	0	18.7	0
2022	-84.4	50	0	19.1	0
2023	-65.8	50	0	19.5	0
2024	-45.4	50	0	19.9	0
2025	-22.9	50	0	20.3	0
2026	4.4	50	7	20.7	339
2027	31.9	50	51	21.1	2,417
2028	61.6	50	99	21.5	4,576
2029	103.5	50	166	22.0	7,537
2030	138.4	50	221	22.4	9,882
2031	185.9	50	297	22.9	13,014
2032	226.7	50	363	23.3	15,558
2033	291.0	50	466	23.8	19,585
2034	348.9	50	558	24.3	23,021
2035	421.1	50	674	24.7	27,241

It is assumed that the annual benefits are mainly reinvested into the industry sector, and 50 % of this reinvestment will be allocated to labor costs that will result in a multiplier effect. If the savings rate of Omani private income (near deposit rate to the public monetary institutes) which affects the multiplier effects is defined at 30 % per year, as a result, the multiplier effect rate in Oman will be 3.2 times the initial labor costs. (The assumption of the consumption cycle is 3 times per year) Omani wage will be 6,000 RO per capita (15,000 US$ per capita-year) in 2013 with an estimated real growth rate of 2 % per year.

Chapter 11 Recommendation

11.1 Proposed EE&C Measures

11.1.1 Outline of the EE&C Measures

Having screened the measures through a simple cost/benefit analysis, this Study proposed the following measures as prioritized measures.

Table 11- 1 Outline of the Proposed EE&C Measures

	Scheme	Summary	Target
1	Energy Management System (EMS)	• Periodical reporting system of energy consumption and EE&C plan from designated consumers. • Assignment of Energy Manager (qualified by the national qualification) on site • Mandatory energy audit for designated consumers	• Factories and buildings which use a certain amount of energy consumption (electricity and fuel) in Industry, Commercial and Government sectors
2	Minimum Energy Standards and Labeling System (MESL)	• Minimum standards for designated products • Display of comparative star according to an efficiency criteria	• AC, Refrigerator & Freezer, Lamp, Washing Machine
3	EE&C Building Regulation (EBR)	• Permission of construction plan including insulation and energy efficiency equipment	• Buildings and houses which use a certain amount of floor area
4	DSM Tariff System (DST)	• Demand Adjustment Contact (Discount tariff for power reduction based on the requests from power utilities) • TOU Tariff System (Optional tariff which has high price in peak time and low price in off-peak time)	• Large electricity consumers who wish to apply for these optional tariffs
5	Smart Meter with Visualization (SM)	• Smart meter with visualization of electricity consumption to improve EE&C awareness of consumers	• All the sectors
6	EE&C Dissemination Program (EDP)	• Nation-wide dissemination programs (Campaign, subsidy, award, awareness survey, etc.)	• All the sectors

11.1.2 Implementation Plan of the EE&C Measures

(1) Implementation Plan

The following points were considered for creating the following schedule.

- Each EE&C measure basically implements per the order of the detailed scheme design, pilot implementation and full-scale implementation.
- A new organization, National EE&C Center (NEEC), is proposed to be established for the executing agency for the Energy Management System and the EE&C dissemination programs. NEEC is planned to start in 2016, and prior to that time, PAEW is expected, as a preparatory body, to plan and prepare the scheme and programs.
- The mandatory programs such as Energy Management System, Minimum Energy Standards and Labeling System, EE&C Building Regulation and the establishment of a

new organization require a legal basis and a one-year preparation period must be considered.

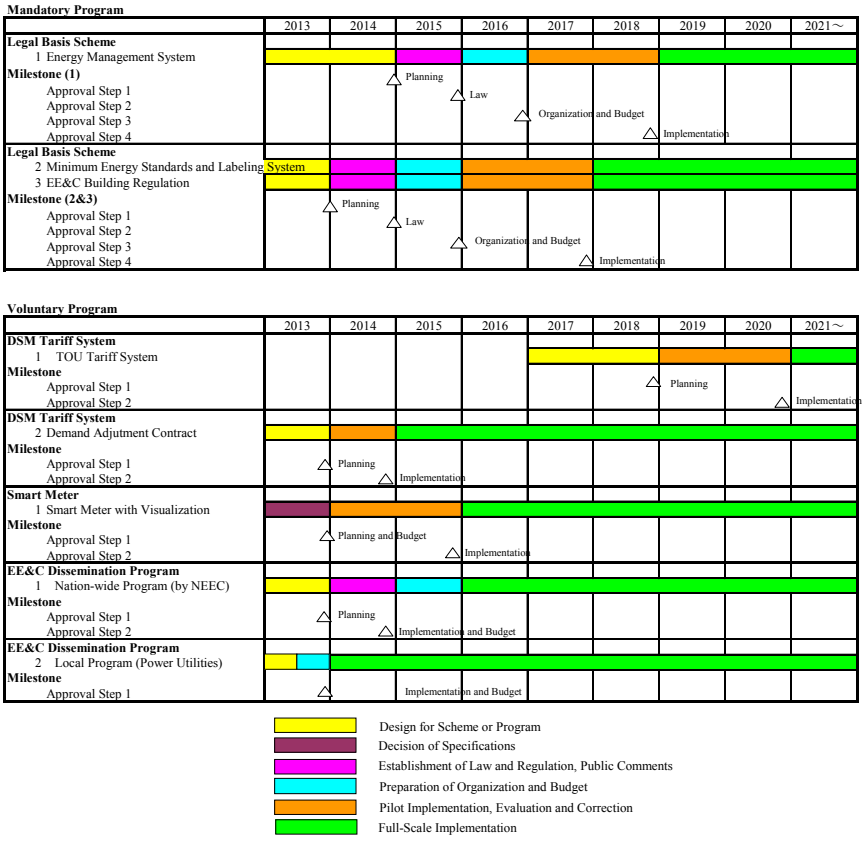


Figure 11- 1 Overall Schedule and Milestone

(2) Estimation of the Governmental Costs (Administration Costs)

The implementation schedule and budget plan of each EE&C measures are proposed as follows (the annual schedule after 2022 is the same as 2021).

Table 11- 2 Implementation Cost of the EE&C Measures **Unit: RO**

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Energy Management System (EMS)									
PAEW	196,800	196,800	296,800	346,800					
NEEC					110,000	110,000	117,500	117,500	117,500
Minimum Energy Standards and Labeling (MESL)									
MOCI	46,800	196,800	96,800	592,800	592,800	222,800	222,800	222,800	222,800
EE&C Building Regulation (EBR)									
NCBC	146,800	146,800	166,800						
Muscat Municipality				110,700	110,700				
All the Municipalities						498,600	498,600	498,600	498,600
MOCI			15,600	15,600	15,600	15,600	15,600	15,600	15,600
DSM Tariff System (DTS)									
AER	158,600	158,600	62,400		158,600	158,600	158,600	158,600	62,400
Smart Meter (SM)									
EHC	96,800	96,800	49,300	2,500	2,500	50,000	2,500	2,500	2,500
EE&C Dissemination Program (EDP)									
PAEW	46,800	66,800	46,800						
NEEC				2,318,600	1,304,200	1,304,200	1,304,200	1,304,200	1,304,200
Total Cost (without Subsidy)	692,600	862,600	734,500	3,387,000	2,294,400	2,359,800	2,319,800	2,319,800	2,223,600
Subsidy for EMS					183,398	183,398	183,398	183,398	183,398
Subsidy for MESL						5,250,000	5,250,000		
Total Cost (with Subsidy)	692,600	862,600	734,500	3,387,000	2,477,798	7,793,198	7,753,198	2,503,198	2,406,998

(3) Proposal of a New Implementation Organization

The Study proposed to establish a new implementation agency, National EE&C Center: NEEC, which can manage the targets of electricity and fuel, as an executing agency for the EE&C dissemination programs, subsidy provision, and Energy Management System.

The following three options were proposed as the organization structure.

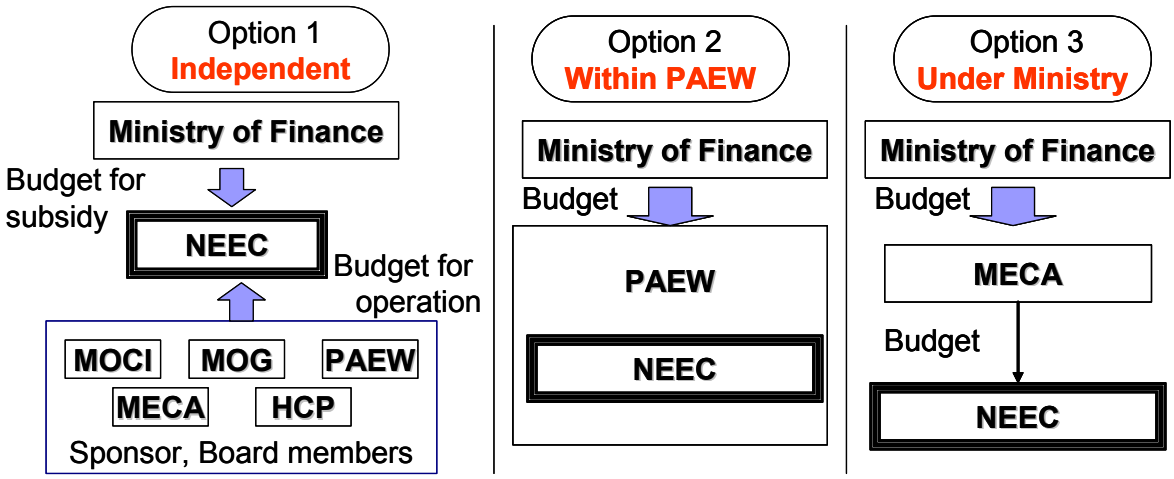


Figure 11- 2 Three Options for the Implementation Structure of NEEC

11.2 Recommendation

From the results of the costs/benefit analysis described in Chapter 10, the proposed EE&C measures are obviously beneficial for Oman. Besides, savings of domestic resources contribute to national energy security. Thus the EE&C policy should be further promoted for

the future of Oman.

Out of the proposed EE&C measures, the Minimum Energy Standards and Labeling System (MESL) and EE&C Building Regulation (EBR) are highly recommended because these schemes are expected to be effective in reducing the electricity consumption of air conditioners which occupies about 40 % of total consumption (about 60 % during the summer peak period). In fact, similar schemes have been already adopted or planned to be introduced in the Middle East countries. From this perspective, the implementation of these measures will be prioritized.

The action plans for the preparation and implementation of each EE&C measure are described in Chapter 8. To steadily achieve the action plans, PAEW, which was a counterpart of the Study, is expected to continue to play a main role as the driving force. Besides, the proposed EE&C measures are related to some ministries, agencies and companies, and solid coordination between such stakeholders is crucially required. In this Study, cross-sectional Sub-Committees were established to discuss the EE&C measures and it is expected that the committees will also continue to be involved in the preparation and implementation of each EE&C measure. The JICA Study Team recommended that PAEW together with the Sub-Committees follow up on this master plan even after completion of the Study.